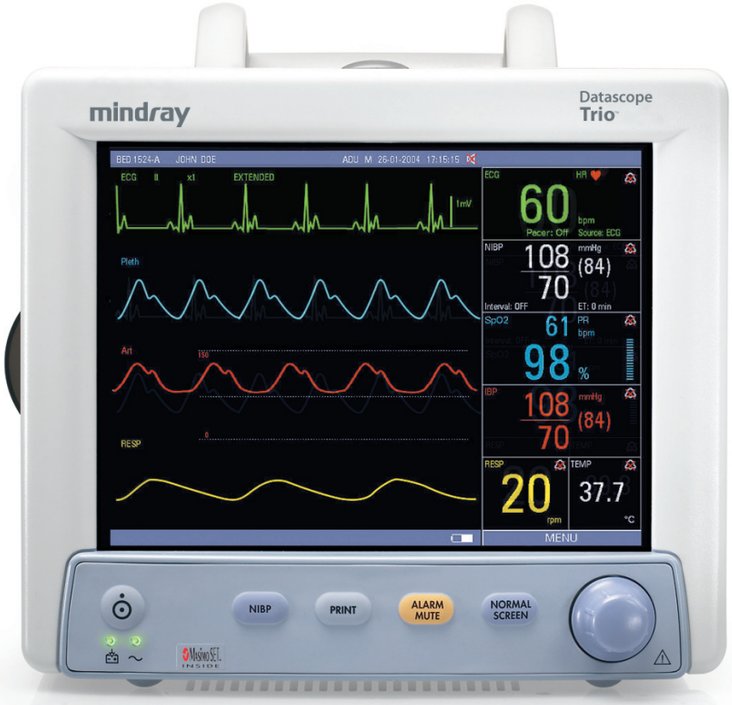
Service Manual

Datascope Trio™



mindray™
NORTH AMERICA

0070-01-0591-02_revB_Trio srv color.indd 1 3/10/10 5:36:48 PM

Service Manual

Datascope
Trio™

mindray™
NORTH AMERICA

Trio™ is a U.S. trademark of Mindray DS USA, Inc.

Velcro® is a registered trademark of Velcro Industries B.V.

Navigator™ is a U.S. trademark of Mindray DS USA, Inc.

Masimo SET® is a U.S. registered trademark of Masimo Corp.

Copyright © Mindray DS USA, Inc., 2008. All rights reserved. Contents of this publication may not be reproduced in any form without permission of Mindray DS USA, Inc.

Foreword iii
Warnings, Precautions And Notes iii
Warning iii
Theory of Operation ..... 1 - 1
Introduction ..... 1 - 1
Hardware Overview ..... 1 - 3
Power Supply Board (Lead Acid Battery) ..... 1 - 3
Power Supply Board (Lithium Ion Battery) ..... 1 - 5
CPU Board (Main Control Board) ..... 1 - 6
Keypad Board ..... 1 - 9
Keypad Board ..... 1 - 10
Keypad Board ..... 1 - 11
TR60-C Recorder ..... 1 - 12
Serial Interface Converter Board ..... 1 - 14
Parameter Circuit Descriptions ..... 1 - 15
ECG ..... 1 - 15
Respiration ..... 1 - 15
NIBP ..... 1 - 16
SpO_2 ..... 1 - 16
Temperature ..... 1 - 17
IBP (optional) ..... 1 - 17
Calibration/Maintenance ..... 2 - 1
Calibration Introduction ..... 2 - 1
Warnings and Guidelines ..... 2 - 1
Test Equipment and Special Tools Required ..... 2 - 1
Calibration and System Checks ..... 2 - 2
Device Appearance and Installation Checks ..... 2 - 2
Maintenance Menu ..... 2 - 2
Safety Tests ..... 2 - 11
Testing Each Parameter ..... 2 - 12
ECG and RESP ..... 2 - 12
NIBP ..... 2 - 12
SpO_2 ..... 2 - 13
TEMP ..... 2 - 14
IBP ..... 2 - 14
Parts ..... 3 - 1
Exploded Views of the Trio Monitor ..... 3 - 1
Parts Listing ..... 3 - 12
Repair Information ..... 4 - 1
Introduction ..... 4 - 1
Single Temp Cable Assembly ..... 4 - 10
ECG Cable Assembly ..... 4 - 10
Troubleshooting ..... 4 - 11
Module-level Troubleshooting ..... 4 - 11
Disassembly Instructions ..... 4 - 14
Tools Needed ..... 4 - 14
Removal of the Front Housing ..... 4 - 14
Removal of Display ..... 4 - 14
Removal of Thermal Printhead Recorder ..... 4 - 14
Removal of PCB Chassis Assembly ..... 4 - 15
Removal of Display Mounting Plate ..... 4 - 15
Replacement of 3V Lithium Cell Battery ..... 4 - 15

Removal of Power Supply Assembly ..... 4 - 15
Removal of PCB Chassis Rear Panel Plate ..... 4 - 15
Removal of NIBP/IBP PCB Mounting Plate ..... 4 - 16
Removal of Handle ..... 4 - 16
ECG Cable ESIS and Non ESIS ..... 4 - 17
ECG Shielded Lead Wires ..... 4 - 18
Trio Wall Mounts and Rolling Stand ..... 4 - 20
Appendix ..... 5 - 1
System Alarm Prompts ..... 5 - 1

Foreword

This service manual gives a detailed description of the **Trio** Portable Patient Monitor, including, circuit descriptions, test procedures and a spare part listing. This manual is intended as a guide for technically qualified personnel during repair, testing or calibration procedures.

Warnings, Precautions And Notes

Please read and adhere to all warnings, precautions and notes listed here and in the appropriate areas throughout this manual.

A **WARNING** is provided to alert the user to potential serious outcomes (death, injury, or serious adverse events) to the patient or the user.

A **CAUTION** is provided to alert the user to use special care necessary for the safe and effective use of the device. They may include actions to be taken to avoid effects on patients or users that may not be potentially life threatening or result in serious injury, but about which the user should be aware. Cautions are also provided to alert the user to adverse effects on this device of use or misuse and the care necessary to avoid such effects.

A **NOTE** is provided when additional general information is applicable.

Warning

WARNING: The NIBP pneumatic test (specified in the EN 1060-1 standard) is used to determine if there are air leaks in the NIBP airway. If the system displays the prompt that the NIBP airway has air leaks, please contact the manufacturer for repair.

CAUTION: To ensure continued use of the Factory Defaults when the unit is powered off and on, save the Factory Defaults as the User Default Configuration after reassembly.

This page intentionally left blank.

1.0 *Theory of Operation*

1.1 Introduction

The **Trio** portable patient monitor uses a parameter module as the basis for acquiring patient data. The results are transmitted to the main control board to process and display the data and waveforms. CPU board commands and status messages of modules are transmitted via databus. The structure of the entire system is shown in the figure below.

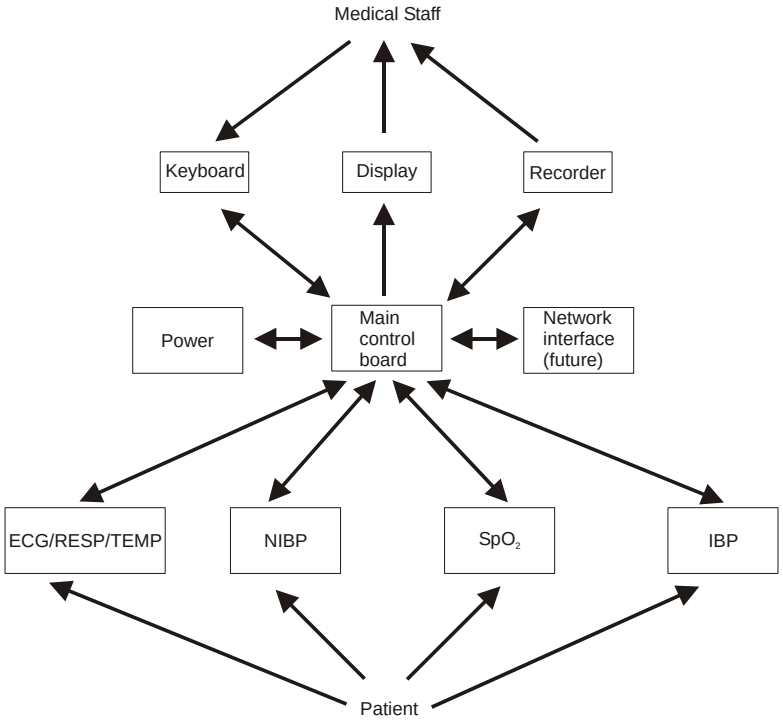


FIGURE 1-1 System Structure Diagram

As shown in the above figure, the four parameter modules execute real-time monitoring of NIBP, SpO_2, ECG/RESP/TEMP and IBP through the use of blood pressure cuffs and patient cables. The patient data is transmitted to the CPU board for display. When required, data may be printed out via the recorder.

1.2 Hardware Overview

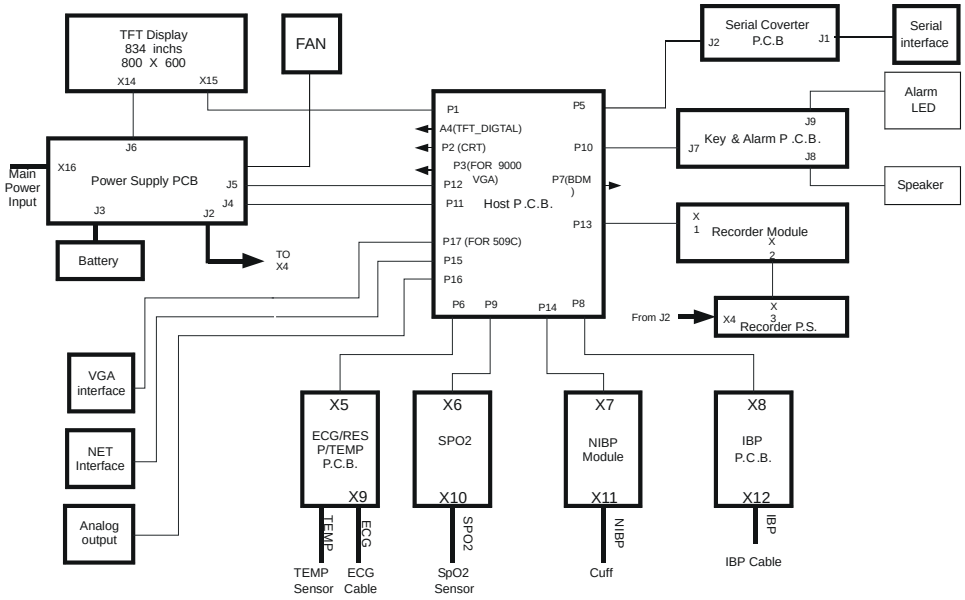


FIGURE 1-2 Connection Diagram

1.2.1 Power Supply Board (Lead Acid Battery)

P/N 0671-00-0235

Trio power supply board specifications:

- AC input voltage:100~250 VAC
- AC input current: <1.6 A
- AC voltage frequency: 50/60 HZ
- Two-way output voltage: 5 V/12 V, normal working current is 1.5 A for 5 V, 2 A for 12 V
- Two-way output voltage has functions of short-circuit, over-current and over-voltage protection
- The power board has reset function
- The power board can manage the charging process of lead-acid battery (12 V/ 2.3 AH). The charging time is 8 hours maximum.

NOTE: **Power Supply Board must be connected to resistive load to operate properly and avoid damage due to an overcurrent condition.**

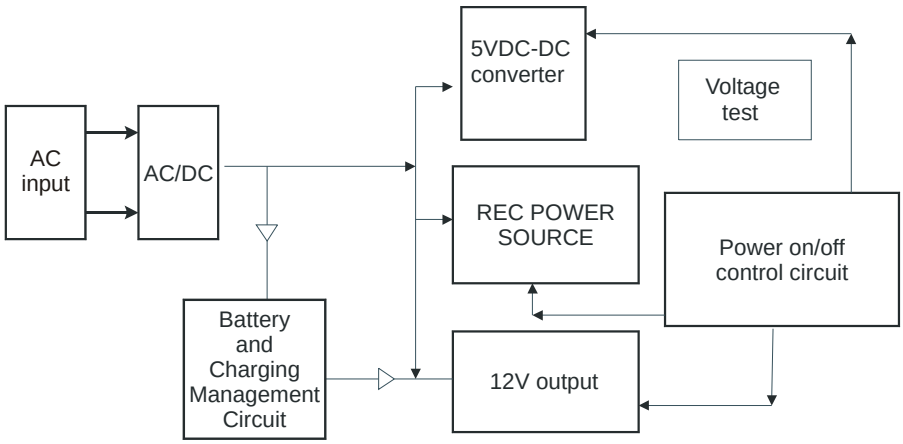


FIGURE 1-3 Block diagram of **Trio** power supply board

Key Test Points

NO.	NAME	LOCATION	FUNCTION
1	Rectified voltage	C12	Primary rectified voltage, range: 107~354 V
2	RTN1	C12 negative electrode	Primary ground
3	Driving waveform	Q1.1	There is a driving waveform of about 100 KHZ between Q1.1 and the negative electrode of C12
4	VIN	C19 positive electrode	17.5 V provide input voltage for DC-DC
5	GND	C19 negative electrode	Secondary ground
6	5B	C47 positive electrode	5 V spare output, provide power for on/off circuit
7	5 V	ZD3 cathode	5 V output, voltage range is 4.75~5.25 V
8	12 V	ZD3 cathode	12 V output, voltage range is 11.0~13.0 V

1.2.2 Power Supply Board (Lithium Ion Battery)

P/N 0671 -00-0051

Trio Power Supply board specifications:

- AC input voltage:110~240VAC+10%
- AC input current: <1.6A
- AC voltage frequency: 50/60+3HZ
- Two-way output voltage: 5V/12V, normal working current is 1.3A for 5V, 1.3A for 12V.
- Two-way output voltage has functions of short-circuit, over-current and over-voltage protection.
- The power board has reset function.
- The power board can manage the charging process of li-ion battery (11.1V/4.4AH). The charging time is 6.5 hours maximum.

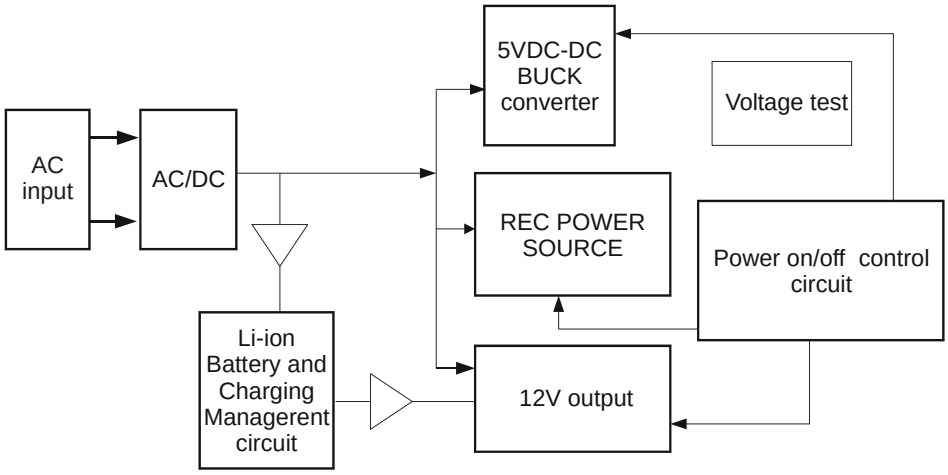


FIGURE 1-4 Block diagram of **Trio** power supply board

Key Test Points

NO.	NAME	LOCATION	FUNCTION
1	Oscillator frequency	Pin 4 of U1	Generate a oscillating frequency about 100kHZ
2	GND	CC61 negative electrode	Primary Ground
3	D-S waveform	Q1.2	There is a waveform of about 100KHZ,107~354V between Q1.2 and the negative electrode of C12
4	Driving waveform	Q1.1	There is a driving waveform of about 100KHZ, 15V between Q1.1 and the negative electrode of C12
5	Rectified waveform	D5 anode	Secondary rectified voltage
6	VIN	C18 positive electrode	17.6V,provide input voltage for DC-DC

Key Test Points

NO.	NAME	LOCATION	FUNCTION
7	12V	C41 positive electrode	12V output, voltage range is 11.0~13.0V
8	5V	C58 positive electrode	5V output, voltage range is 4.75~5.25V
9	Feedback voltage	R37 positive electrode	There is a DC waveform of about 2.5V between R37

1.2.3 CPU Board (Main Control Board)

P/N 0671-00-0056 or P/N 0671-00-0236

1.2.3.1 Overview

Power Supply Input Voltage: +12 V±5%; +5 V±5%

The main control board uses the Coldfire series embedded microprocessor 5206e manufactured by Motorola Company. It also adopts 3.3 V low-voltage power supply to reduce the power consumption. Other main components on the main control board include: Flash, SRAM, FPGA, network controller, etc., all of which require 3.3 V power. The capacity of the Flash is 2 MB or 4 MB*, which employs two parallel-connected 512K x 16 or 1M x 16* chips and therefore uses 32-bit character width to support CPU to operate at the highest possible speed instead of accessing the DRAM for operation. The main control board has also a 4 MB memory, which is made up of two parallel-connected 1M ×16-bit chips. Because no executing program is required to be loaded, only one RTC is used. This chip uses one 225maH dry cell as the spare power supply. In addition, one 2KB E2PROM is used to store parameters. The main control board supports a resolution of 800 x 600 and provides three interfaces: a LVDS interface, a 6 bit digital interface, and a VGA interface. The monitor displays characters and waveforms, in the same color, on the screen. The support system needs 10 serial ports, and the baud rate (4800/9600/19.2 K/38.4 K/76.8 K) can be selected by software and interface buffer drives. The main control board adopts the network controller AX88796 (3.3 V, 10 MHz), which has inside 16 K high-speed buffer SRAM. The MAX5102 8-bit single-way D/A converter is used to fulfill analog output. The 5 V and 12 V regulated voltage supplies are introduced from the power board, and therefore 3.3 V and 2.5 V working supplies are respectively generated. Among them, 2.5 V is to be used for the internal verification of FPGA.

*Applies to P/N 0671-00-0056.

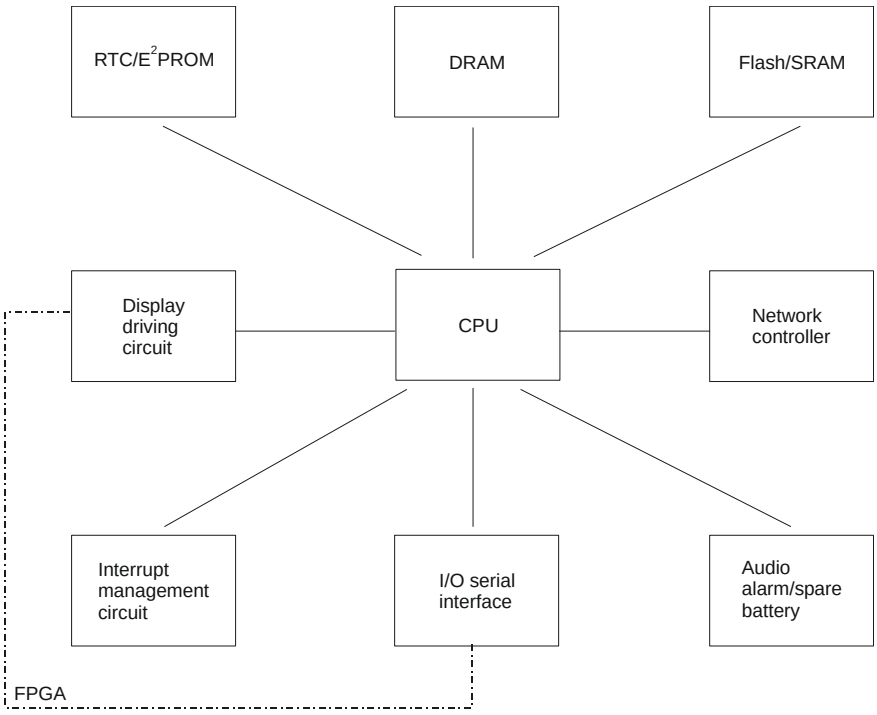


FIGURE 1-5 Block Diagram of **Trio** CPU board

1.2.3.2 Detailed Description

3.3 V low-voltage power supply component is used. The external power is 5 V, which is converted by the DC/DC converter into 3.3 V and 2.5 V, the latter voltage being especially used for FPGA. The main control board is connected to external devices via corresponding interfaces and input: the power supply connected to the interface board, the 9-way serial port, TFT interface, analog VGA interface, network interface, analog output and a spare serial port, etc. The BDM interface, on the board, is reserved for the purpose of software testing and downloads.

CPU

Uses Coldfire 5206e. Clock rate is 54 MHz, working voltage is 3.3 V.

FLASH

Uses two parallel-connected 512K x 16 or 1M x 16* FLASH memories. The output terminal PP1 of CPU is used to realize write-protection of FLASH. It is effective in low-level state.

*Applies to P/N 0671-00-0056.

DRAM

The **Trio** CPU main control board uses two parallel-connected 1M x 16 DRAM, which construct 4M address space.

Display

The resolution is 800 x 600. Frequency is 38 MHz. It works in an appropriate SVGA mode. VRAM adopts 16-bit structure and is divided into an alphanumeric character screen and a waveform screen. To the left of the alphanumeric character screen is the corresponding waveform screen. The character screen is used to display data and flashing alarming parameters. The user can select the color of the waveform and alphanumeric characters for each parameter.

LVDS Interface

By utilizing time-share sampling, the LVDS (Low Voltage Differential Signaling) interface converts multi-channel CMOS/TTL signals into single channel, low-voltage, double-frequency differential signals. LVDS interface is generally realized by a special integrated circuit. The special LVDS chip used for display is DS90CF363A. This chip converts 18-bits of RGB data and 3 bits of LCD timing and control data (21 bits of CMOS/TTL data) into 3 LVDS data streams. Four differential signals including the 3 data streams and a phase-locked frequency are transmitted to the display screen. The working frequency of DS90CF363A is 20~65 MHz.

Reset and Parameter Storage

The CPU board uses an integrated chip CAT1161, which controls both power-on reset and parameter storage. This chip has an E2PROM with the capacity of 2K. It can be used to modify and store various nonvolatile parameters of the host. The power-on reset and WATCHDOG functions are used to realize reset function of the CPU board. When J1 is open circuit, the software can also disable WATCHDOG by using the output signal PP0 of CPU in order to realize the self test of WATCHDOG. The bus interface of this chip is I2C.

Network Controller

The network controller adopts special chip AX88796. Its working clock is 25 MHz. It also has internal 16 K high-speed buffer SRAM. The data bus of this chip is 16-bit width.

Key Test Points

NO.	NAME	FUNCTION
1	V33	Digital supply voltage: +3.3 V
2	V25	FPGA supply voltage: +2.5 V
3	V3	Lithium battery voltage: +3 V
4	CLK	CPU master clock: 54 MHz
5	PCK	FPGA and display clock: 38 MHz
6	NCK	Network chip clock: 25 MHz
7	/RST	System reset signal
8	/NINT	Network chip interrupt signal
9	DO	Signal indicating successful FPGA configuration

1.2.4 Keypad Board

P/N 0671-00-0237

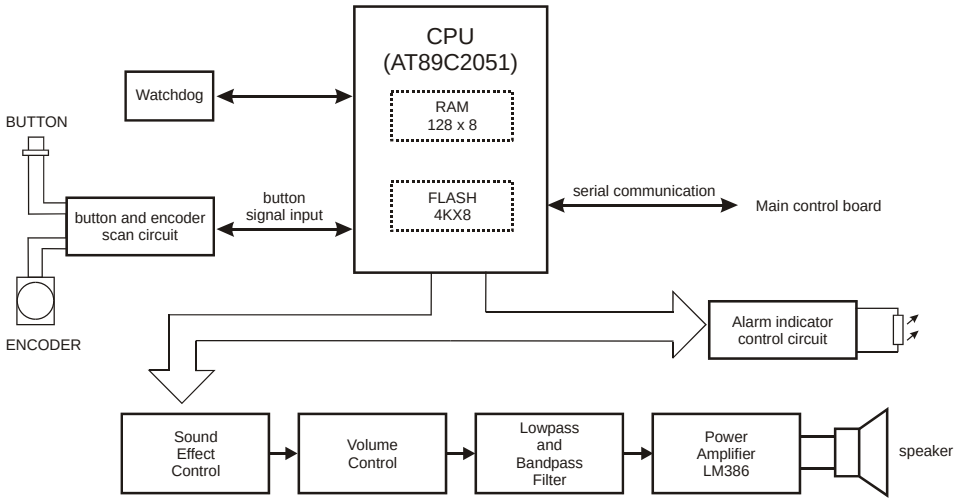


FIGURE 1-6 Keypad Block Diagram

1.2.4.1 Detailed Description

This circuit has three main parts:

1. Alarm Audio Signal Circuit: The alarm audio signal circuit is made up of components including U3, U6, R8, R25, E6 (E1), R11, R12, R3 and R32. P3.3 is used to control the length of the alarm sound. R8, E1 and E6 are used to generate the rise edge and the fall edge of the sound signal. Q1 is used to make the rise edge and fall edge of the low-level alarm slower than those of medium/high-level alarm. D1 is used to generate the heart beat and pulse tone. If P3.2 is high, the alarm square waveform of P3.5 will pass and, as a result, control P3.2 to generate a "heart beat tone" or ''rotary encoder tone''. R11, R12, R3, R32 and R18 together construct a variable voltage-dividing network which, by controlling the state of RA and RB via U3, determines the sound volume level.
2. RC Bandpass Filter/Audio Amplifier: A one-stage RC bandpass filter is used to block the low frequency component of the alarm signal (700 Hz. square wave) before it is input to the audio amplifier, LM386. This bandpass filter is made up of R13, R28, C9, C15, RA and the input resistance R in of LM386.
3. Alarm Indicator Control/Encoder and Key Scanning: The flashing of the alarm indicator in red or green is controlled by the state of microchip P1.6 and P1.7. The microprocessor scans the state of microchips P1.0~P1.2 to determine which key, or if the encoder, is pressed. The microprocessor scans the state of microchips P1.4 and P1.5 to determine if the encoder is turned and in which direction it is turned.

Key Test Points

NO.	NAME	LOCATION	FUNCTION
1	VCC	P4.4	Power input, range: 4.8~5.1V
2	GND	P4.5	Power supply and signal ground
3	RST	U1.1	CPU reset signal. At low level (<0.3V) when operating normally
4	Crystal oscillator	X1.1, X.2	CPU crystal oscillator. Sine wave (1.5~3.5V) when operating normally

1.2.5 Keypad Board

P/N 0671-00-0058

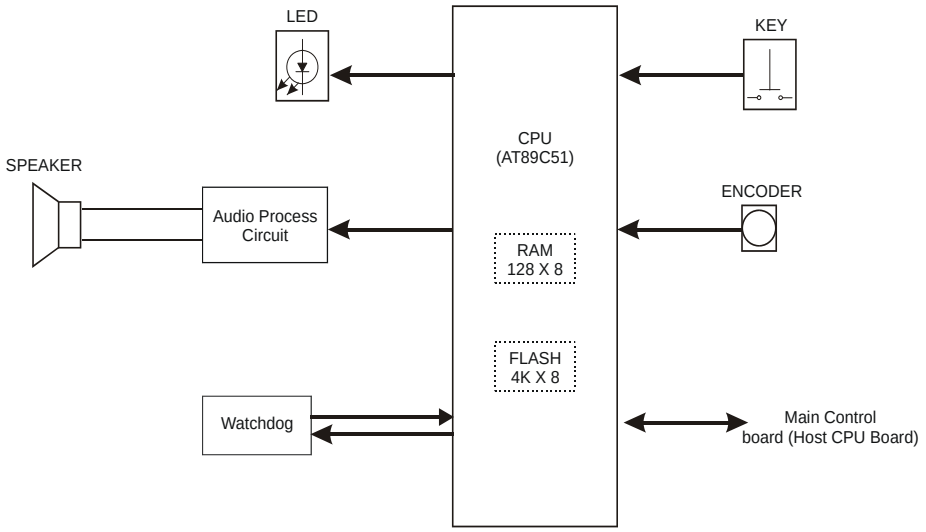


FIGURE 1-7 Keypad block diagram

1.2.5.1 Detailed Description

This module detects key and encoder input signals, converts them into code then sends these coded signals to the main board. The main control board (Host CPU board) in turn sends commands back to the keyboard's control indicator and audio process circuits, which enable or disable audio and visual alarm respectively, as required.

CPU

- Detects key and encoder input signals;
- Controls LED status;
- Controls Audio Process Circuit;
- Regularly zeroes Watchdog Timer;
- Communicates with main board.

Audio Process Circuit

Generates audio signals to drive the speaker.

Watchdog

- Upon power-up, supplies Reset signal to CPU;
- Provide functions of Watchdog Timer Output and voltage detection.

Key Test Points

NO.	NAME	LOCATION	FUNCTION
1	VCC	P4.4	Power input, range: 4.8~5.2V
2	GND	P4.5	Power supply and signal ground
3	RST	U1.10	CPU reset signal. At low level(<0.3V) when operating normally
4	Crystal oscillator	X1.1,X.2	CPU crystal oscillator. Sine wave signal (1.5~3.5V) when operating normally

1.2.6 Keypad Board

P/N 0671-00-0064

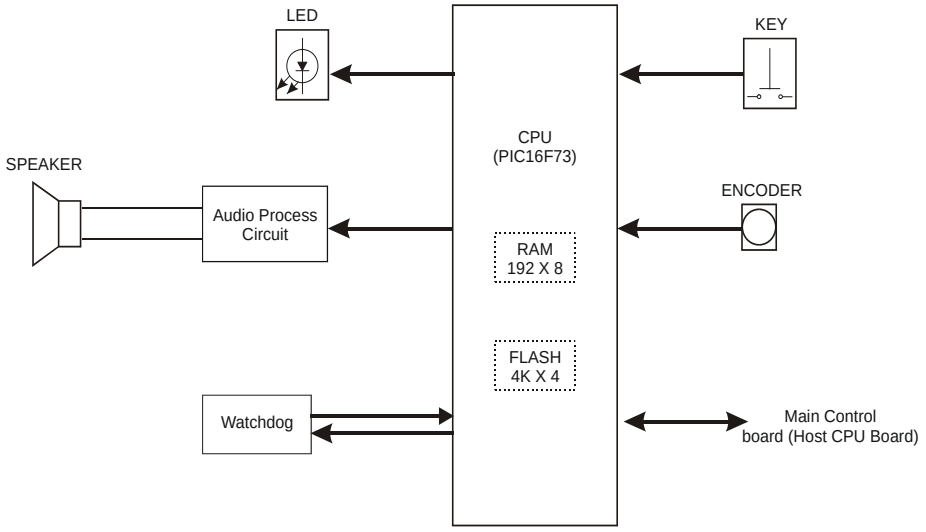


FIGURE 1-8 Keypad block diagram

1.2.6.1 Detailed Description

This module detects keypad and encoder input signals, converts them into code and transmits the code to the Host CPU board. The Host CPU board sends commands to the keyboard which in turn controls the indicator and audio process circuits, activating audio and visual alarms accordingly.

CPU

The Keypad Board's CPU is responsible for the following functions:

- Detects keypad and encoder input signals
- Controls LED status
- Controls Audio Process Circuit
- Regularly zeroes Watchdog Timer
- Communicates with main board.

Audio Process Circuit

Generates audio signals to drive the speaker.

Watchdog

- Upon power-up, supply Reset signal to CPU
- Provide functions of Watchdog Timer Output and voltage detection.

Key test points

NO.	NAME	LOCATION	FUNCTION
1.	5V/5B	J5 pin 1	Power input, range: 4.0~5.5V
2.	GND	J5 pin 2	Power supply and signal ground
3.	RST	J5 pin 3	CPU reset signal. At low level(<0.8V (during normal operation)
4.	Crystal oscillator	X1 pin 1,X1 pin 2	CPU crystal oscillator. Sine wave signal 1.5~3.5V (during normal operation)

1.2.7 TR60-C Recorder

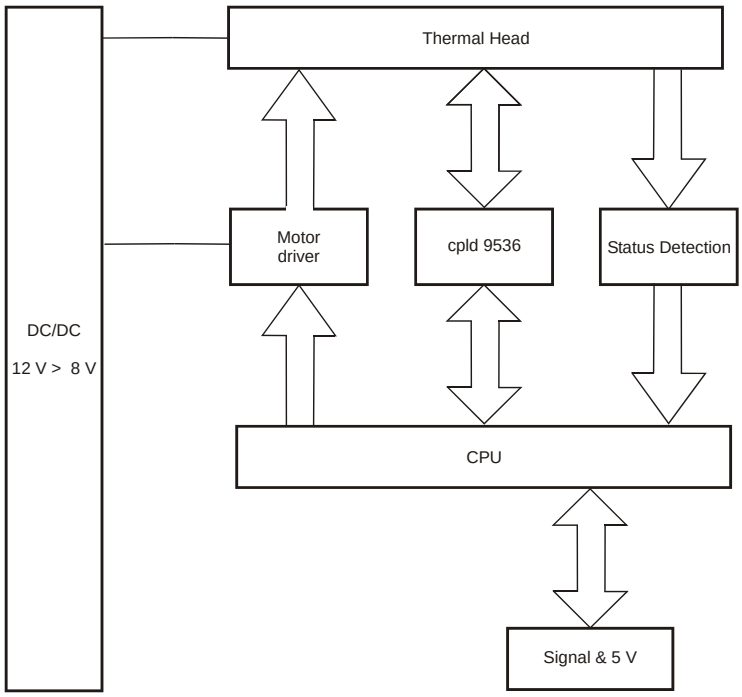


FIGURE 1-9 Block Diagram of TR60-C drive board

1.2.7.1 Detailed Description

Thermal Head

The thermal head, the core component in the TR60-C recorder, is the PTMBL1300A thermal head, manufactured by the ALPS company.

CPU System

The CPU system is the core of the drive board. Its task is to receive the data from the host and generate lattice messages after calculation using a specified algorithm. These messages are then sent to the thermal head for printing. The CPU system can simultaneously collect data from both the thermal head and the drive board and display data sent to the host.

Power Conversion

The recorder requires the system to provide two voltages: 12 V and 5 V. The 5 V is directly driven by the logic and analog circuit of the drive board and the thermal head. Its current is less than 150 mA. The 12 V is converted into 8 V (by the DC/DC on the board) to drive the thermal head and the motor. The current required is determined by the printing content and ranges from 0.5 A to 2 A.

Motor Drive

A small motor is used to control the paper movement at the thermal head. The processor on the drive board uses two motor drives IC LB1843 V to control and drive the motor. These two IC's use constant current to control and drive the motor.

Status Detection

To correctly and safely control and drive the thermal head and the motor, the drive board must use the sensor inside the thermal head to detect the following signals: the position of the chart paper, if the chart paper is installed and if the temperature of the thermal head has exceeded the limit.

Key Test Points

NO.	NAME	LOCATION	FUNCTION
1	12 V	JP3.1	Power input, range: 10~18 V
2	GND	JP3.2	Power and signal ground
3	VPP	U7.8	Power supply for heating thermal head and drive motor: 7.8 V~8.4 V
4	VCC	U1.14	+5 V supply: 4.75~5.25 V
5	RESET	U3.10	CPU reset signal. At high level(>2.4 V) after power-on

1.3 Serial Interface Converter Board

The Serial Interface Converter Board is used to convert the TTL level (5V) to RS232 level.

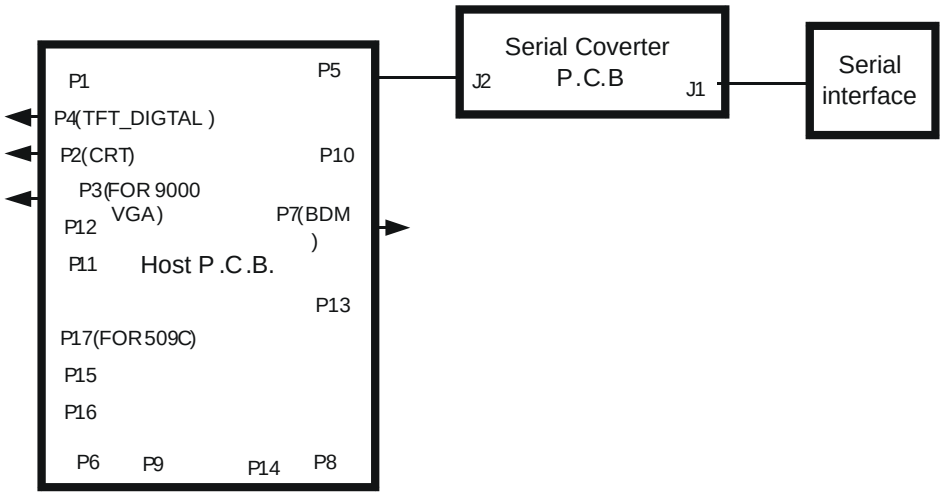


FIGURE 1-10 Serial Interface connection diagram

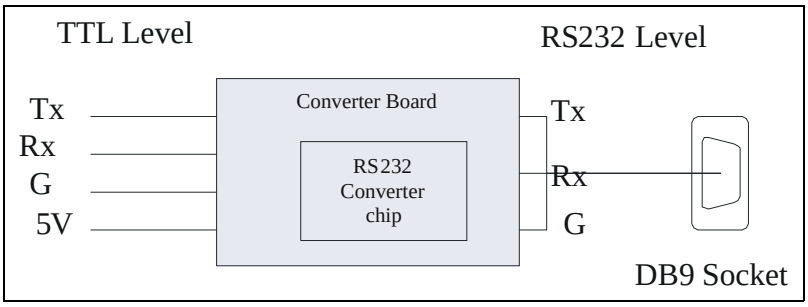


FIGURE 1-11 Block diagram of Serial Interface Converter Board

1.4 Parameter Circuit Descriptions

1.4.1 ECG

The main functions concerning ECG are:

- Lead: 3-lead, 5-lead
- Lead Method; I, II, III, avR, avL, avF, V, CAL
- Floating Input
- Right-Leg Drive
- Lead-off Detection

The ECG circuit is responsible for processing the ECG signals of human body. The circuit consists of following parts:

Input Circuit: The ECG electrodes are connected into the circuit through the cable. This circuit is mainly used to protect ECG input stage and filter the signals so as to remove the outside interference.

Buffer Amplifying Circuit: Used to convert the impedance of ECG signals, so as to ensure that the ECG has a very high input impedance but only low output impedance.

Right-Leg Drive Circuit: The middle output point of the buffer amplifying circuit is reversely amplified and then fed to the RL of the 5-lead ECG to maintain the human body in a equipotential state. This method can reduce the interference and raise the common-mode rejection ratio of the circuit.

Lead-off Detection: Based on the theory that the lead-off may cause the output of the buffer amplifying circuit to change, we can use the comparator to accurately determine if the lead has fallen off. In this way, the level can also be converted into TTL level for the MPU to test.

Main Amplifying Circuit: A measurement amplifier consisting of three standard operation amplifiers.

Last Stage Processing Circuit: Used mainly to couple ECG signals, program control of the gain amplifier, filter the waveform and move the level, amplify the signal and send it to the analog-to-digital converter.

1.4.2 Respiration

Respiration is measured by the thoracic impedance method. When a person is breathing, his chest moves up and down. This movement equals the impedance change between electrodes RA and LL. The monitor converts the high-frequency signals passing through RA and LL into amplitude-modulated high-frequency signals, which are then demodulated and amplified into electronic signals varying with the respiration changes and then transmitted to analog-digital converter. The RESP module is made up of a respiration circuit board and a coupling transformer. The circuit includes stages such as: oscillation, coupling, demodulation, preliminary amplification and high-gain amplification.

1.4.3 NIBP

The monitor measures non-invasive blood pressure using the oscillometric method. Detailed measurement procedures follows:

1. Inflate the cuff encircled around the upper arm until the pressure in the cuff blocks the blood flow in the artery of the upper arm.
2. Then deflate the cuff according to the requirement of the algorithm.
3. With the pressure decreasing in the cuff, the arterial blood will palpitate with the pulse, which results in pulsation in the cuff. Through the pressure sensor, connected to the bladder of the cuff, a pulsation signal synchronous with the patient's pulse will be generated.
4. After being filtered by a high-pass filter (about 1 Hz), this signal becomes the pulsating signal and is amplified. The amplified signal is then converted into a digital signal by the A/D converter.
5. After processing this digital signal, systolic pressure, diastolic pressure and mean pressure can be obtained. To avoid measurement errors, choose appropriate cuffs for patient size. The NIBP module also has an overpressure protection circuit to prevent the cuff from being inflated to a very high pressure.

The main operating modes of NIBP are:

A. Adult/Pediatric

Select according to the patient size, weight and age.

B. Manual Measurement

Manual measurement is also called single measurement. It means the monitor only performs one measurement for each time the **NIBP** key is pressed.

C. Interval Measurement

Interval measurement means to perform one measurement within selected time cycle. Time intervals can be set up as: **1**, **2**, **3**, **4**, **5**, **10**, **15** and **30** minutes, **1**, **2**, and **4** hours, **OFF**, **CONT.** (Continuous). If set to continuous, the monitor will perform a measurement continuously for 5 minutes then revert to an interval setting of 5 min. Continuous measurement is effective in monitoring changes in blood pressure.

1.4.4 SpO_2

SpO_2 Plethysmograph measurement is employed to determine the oxygen saturation of hemoglobin in the arterial blood. If, for example, 97% hemoglobin molecules in the red blood cells of the arterial blood combine with oxygen, then the blood has a SpO_2 oxygen saturation of 97%. The SpO_2 numeric on the monitor will read 97%. The SpO_2 numeric shows the percentage of hemoglobin molecules which have combined with oxygen molecules to form oxyhemoglobin. The SpO_2/Pleth parameter can also provide a pulse rate signal and a plethysmograph. Arterial oxygen saturation is measured by a method called pulse oximetry. It is a continuous, non-invasive, method based on the different absorption spectra of reduced hemoglobin and oxyhemoglobin. It measures the amount of light that is transmitted through patient tissue (such as a finger or an ear).

The sensor measurement wavelengths are nominally 660 nm for the Red LED and 940 nm for the Infrared LED. Maximum optical power output for LED is 4 mW. The amount of light transmitted depends on many factors, most of which are constant. However, one of these factors, arterial blood flow, varies with time because it is pulsating. By measuring the light absorption during a pulsation, it is possible to derive the oxygen saturation of the arterial blood. Detecting the pulsation gives a pleth waveform and pulse rate signal. The SpO_2 value and the pleth waveform can be displayed on the main screen.

1.4.5 Temperature

The temperature circuit can amplify and filter the input signal of the temperature probe and then output it into the A/D sampling circuit on the ECG/RESP board. This circuit consists of sampling switching, constant-current supply, signal amplifier, filter and probe detector. The output signal of the circuit has clamping protection to ensure that the output voltage is less than VCC. The circuit also has a self-calibrating function.

1.4.6 IBP (optional)

Invasive Blood Pressure monitors arterial pressure, central venous pressure and pulmonary arterial pressure.

IBP may be measured by inserting the catheter into the appropriate blood vessel. The end of the catheter, located outside the human body, should connect directly to the pressure transducer.

Inject normal saline into the catheter. Since the liquid can transfer pressure, the pressure inside the blood vessel can be transferred to the outside pressure transducer. In this way we can obtain the waveform of the dynamic pressure inside the vessel. Systolic, diastolic and mean pressures are calculated by using an algorithm.

This page intentionally left blank.

2.0 *Calibration/Maintenance*

2.1 Calibration Introduction

The following procedures are provided to verify the proper operation of the **Trio** Monitor. A menu driven interface is used to execute all verification tests.

2.2 Warnings and Guidelines

In the event that the instrument cover is removed, observe these following warnings and general guidelines:

1. Do not short component leads together.
2. Perform all steps in the exact order given.
3. Use extreme care when reaching inside the opened instrument. Do not contact exposed metal parts which may become ''live''.
4. Read through each step in the procedure, so it is understood prior to performing the step.

2.3 Test Equipment and Special Tools Required

- Digital or Mercury Manometer w/bulb and valve 0-300 mmHg
- Test Chamber/Dummy Cuff (P/N 0138-00-0001-03)
- DVM
- Patient Simulator
- Safety Analyzer (Dempsy Model 431 or Equivalent)
- Metric Ruler
- PC or Laptop w/Windows 98 or above, CD-ROM drive, and Ethernet card installed

2.4 Calibration and System Checks

2.4.1 Device Appearance and Installation Checks

Inspect the **Trio** Monitor to ensure that:

- The outer housing of the device is clean and has no scratches or cracks
- When shaking the device, there are no loose components
- All keys are smooth and free for operation
- Labels are complete, sufficient and accurate
- Standard configuration is complete and all connectors are installed securely

2.4.2 Maintenance Menu

The **MAINTENANCE** menu provides access to all user operable calibration checks. It also provides access to certain technical information and settings. To access the **MAINTENANCE** menu, turn the unit on, rotate the Navigator™ knob to highlight the **MENU** icon at the bottom of the screen and push the knob to select the **SYSTEM MENU**. From the **SYSTEM MENU**, select **MAINTENANCE**.

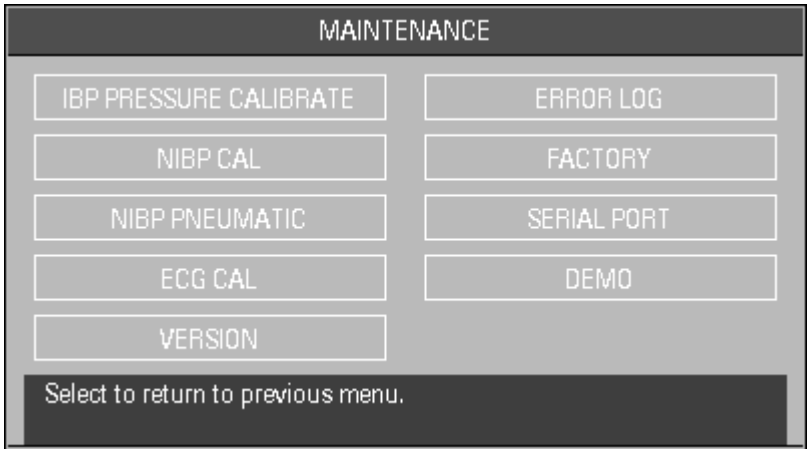


FIGURE 2-1 Maintenance Menu DIAP units (S/N MC15000-XX and above)

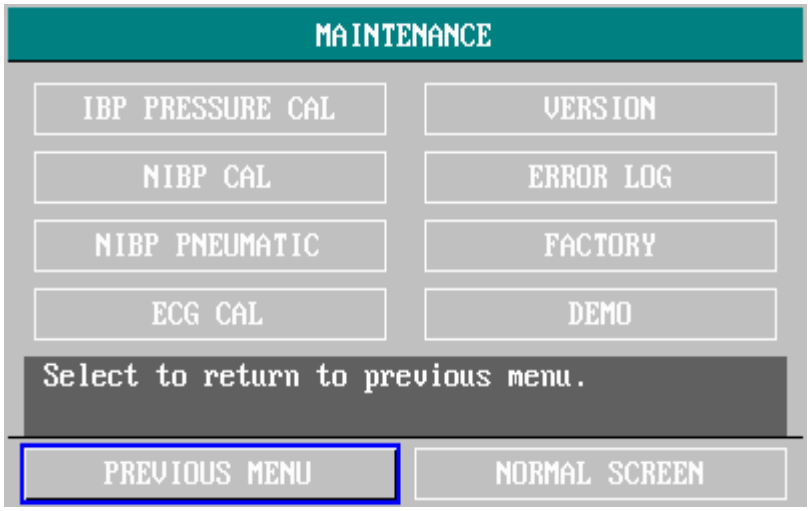


FIGURE 2-2 Maintenance Menu (below S/N MC15000-XX)

2.4.2.1 Calibrations

Calibrations should be performed at least once a year. Calibrations should also be performed after any preventive maintenance or repair of the **Trio** Monitor.

From the **MAINTENANCE** menu make the following selections to perform each specific calibration or check.

IBP Pressure Cal

The purpose of this calibration is to ensure that the system gives you accurate measurements.

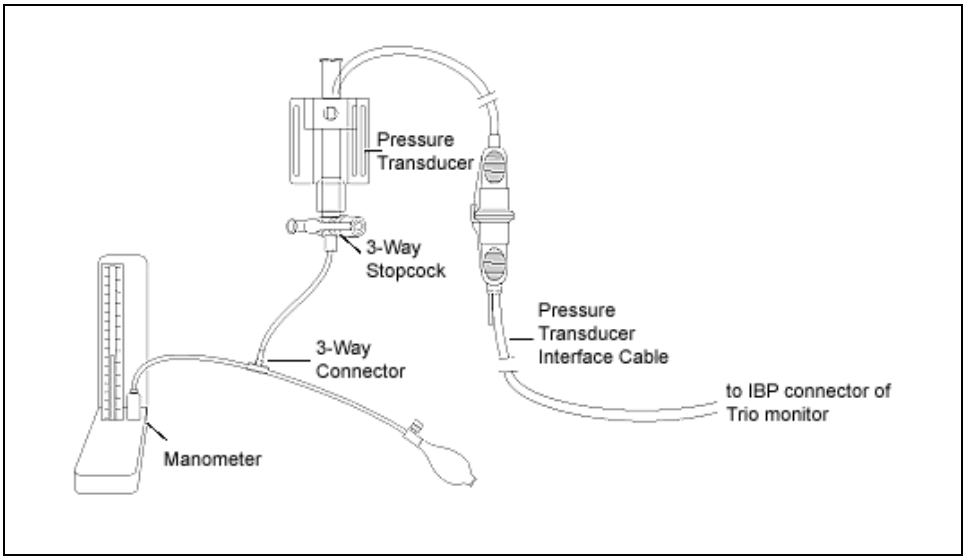


FIGURE 2-3 IBP Calibration

WARNING: Never perform this procedure while patient is being monitored.

1. Connect a Pressure Transducer Interface Cable from a Pressure Transducer (Figure 2-3) to the IBP socket on the right side panel of the **Trio**
2. Open 3-Way Stopcock to atmosphere.
3. Perform zeroing procedure by selecting the **IBP** parameter menu, then selecting **IBP ZERO** tile.
4. From **IBP ZERO** menu select **IBP ZERO** tile to zero the blood pressure channel.
5. Connect a Sphygmomanometer or a digital Manometer w/bulb to the Pressure Transducer via a T fitting.
6. Close the 3-way Stopcock.
7. Manually pump the Manometer to a static value of 100 mmHg and close valve on bulb.
8. From the **MAINTENANCE** menu, select **IBP PRESSURE CAL**.
9. From **IBP PRESSURE CAL** menu, select the tile adjacent to **CAL VALUE** and set to 100 mmHg.

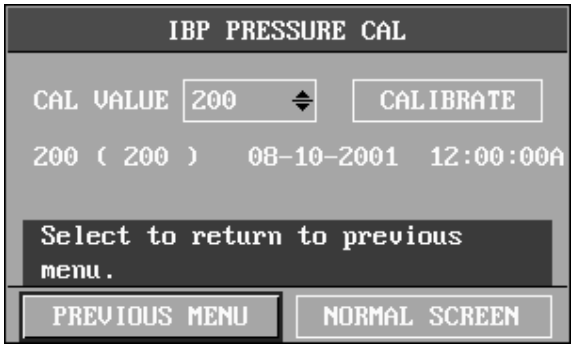


FIGURE 2-4 IBP Pressure Calibration Menu

10. Select **CALIBRATE**. The monitor will perform the calibration and display one of the following calibration completion messages.

MESSAGE	DESCRIPTION
SUCCESSFUL CALIBRATE	Indicates Blood Pressure was calibrated successfully. No further action required.
SENSOR OFF, FAIL	Check that sensor is connected, then proceed with calibration. If message does not clear contact Customer Service.
IN DEMO, FAIL	Check that the monitor is not in DEMO mode. If message does not clear contact Customer Service.
PRESSURE OVER RANGE, FAIL	Check that you have selected appropriate transducer value in IBP CAL, then proceed with calibration. If message does not clear contact Customer Service.

NIBP CAL

Connect a test chamber (P/N 0138-00-0001-03) and a calibrated digital mercury manometer with bulb via T fitting to the NIBP quick connect fitting of the **Trio** Monitor (Figure 2-5.)

1. From the **MAINTENANCE** menu select **NIBP CAL**. The selected tile will now read **STOP CAL**. The user may select this tile at any time to stop the test.
2. Using the bulb, inflate the pneumatic system so that the digital mercury manometer reads 0, 50 and 200 mmHg in turn. The difference between the indicated pressure of the digital mercury manometer and the indicated pressure in the **NIBP** parameter tile of the **Trio** Monitor should not exceed 3 mmHg. If it exceeds 3 mmHg, please contact a service technician.

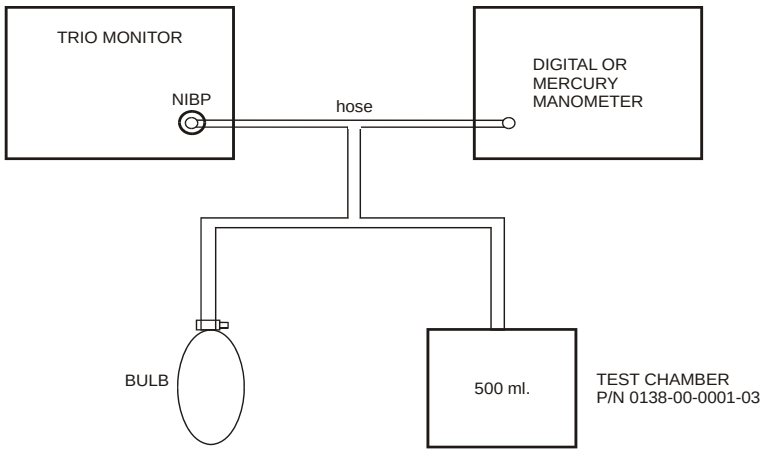


FIGURE 2-5 Diagram of NIBP Calibration

NIBP Pneumatic

WARNING: The NIBP pneumatic test (specified in the EN 1060-1 standard) is used to determine if there are air leaks in the NIBP airway. If the system displays the prompt that the NIBP airway has air leaks, please contact the manufacturer for repair.

1. Connect a test chamber (P/N 0138-00-0001-03) to the NIBP quick connect fitting on the **Trio** Monitor (Figure 2-7).
2. From the **MAINTENANCE** menu, select **NIBP PNEUMATIC**. The NIBP pump will begin to run and the message **STOP PNEUM** will appear in the selected tile. The user may select this tile at any time to end the test.

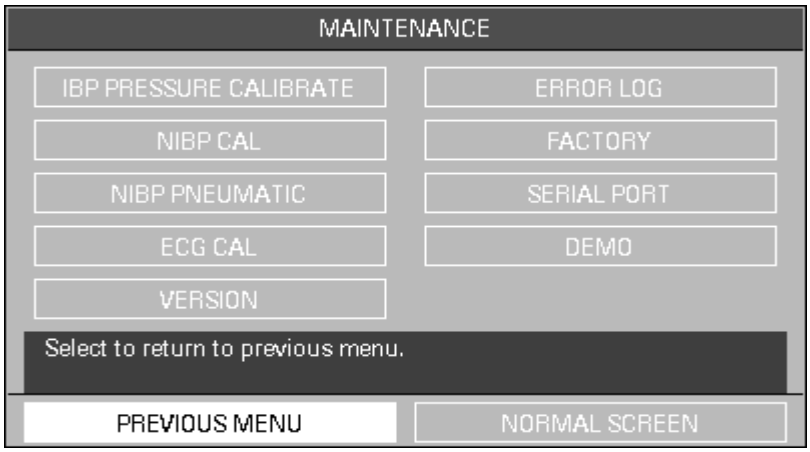


FIGURE 2-6 Maintenance Menu

3. The prompt **Pneum testing...** will appear at the bottom of the NIBP parameter area indicating that the system has started performing the pneumatic test.
4. The system will automatically inflate the pneumatic system to about 180 mmHg.

After approx. 20 seconds, the system will automatically deflate, marking the completion of the test.

If no message appears at the bottom of the NIBP parameter area, no air leaks exist.

If the message **PNEUMATIC LEAK** appears at the bottom of the NIBP parameter area, the NIBP module may have air leaks. The user should first check for loose connections.

After confirming connections, the user should repeat the pneumatic test. If the **PNEUMATIC LEAK** message still appears, please contact the manufacturer for repair.

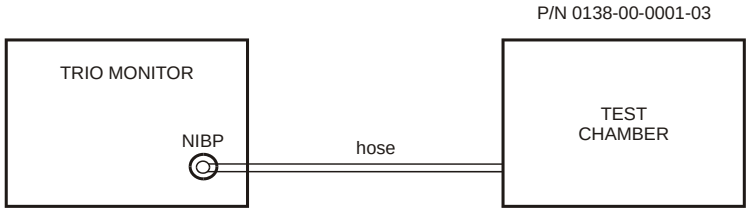


FIGURE 2-7 Diagram of NIBP Air Leakage Test

ECG Cal

1. Set ECG lead to I and ECG size to x1.
2. From The **MAINTENANCE** menu select **ECG CAL**. The message **CALIBRATION MODE** will appear in red at the lower left of the ECG waveform area. The highlighted tile will now read **STOP CAL**. The user may select this tile at any time to end the test.
3. A 1mV peak to peak square wave will appear in the ECG waveform area. This is the Cal Pulse.
4. Measure the amplitude of the Cal Pulse with a metric ruler. The Cal Pulse should measure 1 cm +/- 5%.
5. Set ECG size to x 2. Cal Pulse should measure 2 cm +/- 5%.
6. Set ECG size to x .25. Cal Pulse should measure 25 mm +/- 5%.
7. Set ECG size to x .5. Cal Pulse should measure 50 mm +/- 5%.
8. If any measurements are out of tolerance range, please contact the manufacturer for repair.

2.4.2.2 Technical Information and Settings

From the **MAINTENANCE** menu select each tile to access specific technical information or settings.

Version: This menu will display the current version of the unit's software.

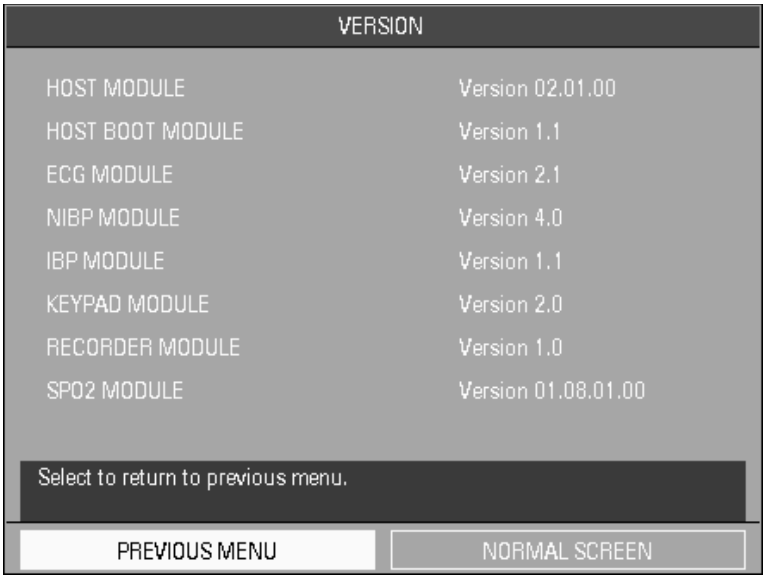


FIGURE 2-8 Version Menu*

*Applies only to host software version 02.01.00 and greater.

Error Log: This menu will display any system errors which may have occurred during normal operation of unit. **SCROLL** or **PRINT** this information by selecting the respective tiles

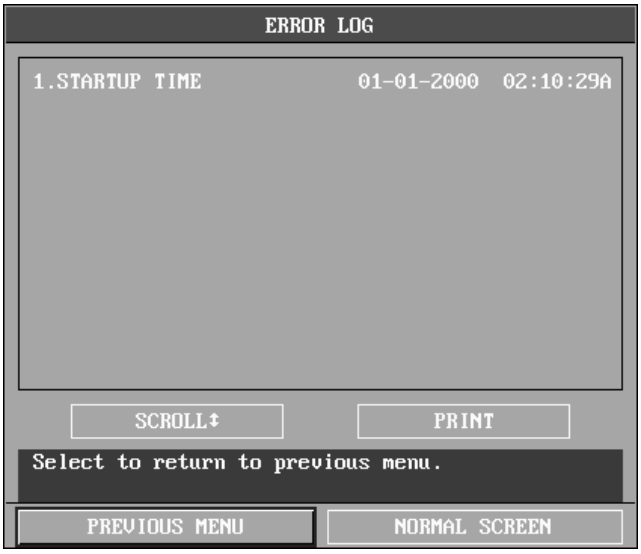


FIGURE 2-9 Error Log Menu*

Factory: This menu allows the unit to be preconfigured at the factory. This menu is enabled with an access code, 762718, and should only be accessed as necessary by Customer Service Personnel or by trained Bio-medical technicians after replacing defective modules as a result of unit repair.

The Factory menu allows for configuration of:

Serial Port: This menu allows the user to configure the DIAP baud rate of the serial output port. The choices are 9600 bps or 19200 bps.

- Language (English, Spanish*, French*, German*, Italian*, Chinese*).
- Module Options (ECG, Resp, SpO_2, 1ch.Temp, 2ch.Temp*, NIBP, IBP, Recorder).

Selections are enabled or disabled by checking or unchecking the box which corresponds to each item in the menu.

NOTE: IBP and 2ch. Temp should not be enabled simultaneously.

**Not available for domestic units.*

FIGURE 2-10 Factory Menu

Demo: This menu allows the unit to operate in Demonstration Mode. When the unit is operating in Demonstration mode the word **DEMO** will be displayed on the screen at all times. This menu is enabled with an access code and should be used for demonstration purposes only.

FIGURE 2-11 Demo Menu

2.4.3 Safety Tests

Equipment: Safety Analyzer (Dempsey Model 431 or equivalent).

2.4.3.1 Leakage Current Tests

Case Leakage

1. Plug the line cord of the unit into the safety analyzer.
2. Connect the case ground lead of the analyzer to the equipotential lug of the monitor (at rear of monitor).
3. Perform the tests under the following conditions:
   a. Case Grounded:
      Normal polarity
      Polarity with open neutral
   b. Case Ungrounded
      Normal polarity
      Polarity with open neutral
      Reverse polarity
4. Verify the current reading of the test is <100µA under normal operating conditions; <300µA under a single fault condition for 120 VAC and <500µA under a single fault condition for 230 VAC.

Patient Leakage

1. Perform the test under the following conditions:
   a. Lead to ground: Sink current patient circuit (Test V Model 431 Dempsey)
   b. Patient leakage with line voltage on leads
2. Connect the ground wire from the safety analyzer to the equipotential lug of the monitor.
3. Connect the ECG cable from the analyzer to the monitor.
4. On the safety analyzer, depress the **APPLY 115 VAC** button and note the reading.
5. Repeat the test for normal and open ground polarity combinations.
6. Verify the current readings of the test are <50µA under a single fault condition.

2.5 Testing Each Parameter

Testing each parameter annually ensures the accuracy of the **Trio** Monitor. The following tests should be used for verification of operation only. The following tests should not be considered calibration procedures.

2.5.1 ECG and RESP

2.5.1.1 Test Equipment

- Patient Simulator

2.5.1.2 Test Procedures

1. Use a 5L patient cable and lead wires to connect a calibrated patient simulator to the ECG connector of **Trio**.
2. Set ECG lead to lead II and ECG size to x1.
3. Check if ECG waveforms and RESP waveforms are displayed.
4. Set up the parameters of the simulator as follows:

   HR=30 (gain × 4)
   RR=15
5. Check if the displayed ECG and RESP waveforms, HR and RR values are correct.
6. Change the simulator configuration:

   HR=240
   RR=120
7. Check if the displayed ECG and RESP waveforms, HR and RR values are consistent with the parameters set up on the simulator.
8. Remove ECG lead. In this condition, the **Trio** should immediately alarm and display **ECG LEAD OFF** at the top right side of the Message Area.

2.5.2 NIBP

2.5.2.1 Test Equipment

- NIBP Simulator
- NIBP Dummy Cuff/Chamber

2.5.2.2 Test Procedures

1. Use polyurethane tubing to connect the **Trio** Monitor to a calibrated NIBP simulator and an NIBP Dummy Cuff/Test Chamber (P/N 0138-00-0001-03) via a T fitting.
2. Select **Adult** mode for both the NIBP simulator and the **Trio** Monitor.
3. Select a group of blood pressure values within the measurement range on the NIBP simulator, such as:

   Systolic = 90
   Mean = 70
   Diastolic = 60
4. From the **NIBP SETUP** menu set **INTERVAL** to **1 min**.
5. Press the **NIBP** key on the front panel keypad.
6. Allow the **Trio** Monitor to acquire NIBP readings for 10 minutes. Check readings for consistency. Reading should not deviate greater than +/- 5 mmHg.

NOTE: **The actual measured values of Trio Monitor may not be consistent with those selected on the simulator. This test is implemented only to confirm repeatability of dynamic NIBP readings. Accuracy can only be confirmed by performing the NIBP CAL outlined in section 2.4.2.1 of this Manual.**

7. Change the NIBP simulator Systolic, Mean and Diastolic settings, and test again

2.5.3 SpO_2

2.5.3.1 Test Equipment

- SpO_2 simulator

2.5.3.2 Test Procedures

1. Connect the appropriate SpO_2 probe to the SpO_2 connector of the **Trio** Monitor.
2. Connect the SpO_2 probe to a calibrated SpO_2 simulator.
3. From the **ECG SETUP** menu set **SOURCE** to **SpO_2**.
4. Set up the parameters of SpO_2 simulator as following:

   SpO_2=98
   PR=70
5. Check that the SpO_2 and PR values displayed on the **Trio** Monitor are equal to the SpO_2 simulator values +/- 2%.
6. Change the SpO_2 and PR values on the simulator.
7. Check that the displayed values on **Trio** are equal to the SpO_2 simulator values +/- 2%.
8. Remove SpO_2 sensor. **Trio** should immediately alarm and display the message **SpO_2 SENSOR OFF** in the message area in the top right corner of the display.

2.5.4 TEMP

2.5.4.1 Test Equipment

- Patient Simulator

2.5.4.2 Test Procedures

1. Connect a 400 series TEMP test cable to the TEMP connector of the **Trio** Monitor.
2. Connect the 400 series test cable to a calibrated Patient Simulator.
3. Set the simulator to output a temperature of 34°C.
4. Check that the displayed TEMP value on the **Trio** Monitor is 34°C +/- .1°C.
5. Change the simulator to output a value of 40°C.
6. Check that the displayed TEMP value on the **Trio** Monitor is 40°C +/- .1°C.

2.5.5 IBP

2.5.5.1 Test Equipment

- Patient Simulator

2.5.5.2 Test Procedures

1. Use a pressure transducer cable to connect a calibrated Patient Simulator to the **Trio** Monitor.
2. Set the **IBP** sensitivity of the simulator to 5uv/v/mmHg, and the static IBP value to 0 mmHg. Set the **IBP** label to **ART**.
3. Perform zero calibration for **IBP**. Select the **IBP PARAMETER** menu to open the **IBP SELECT** menu.
4. From the **IBP SELECT** menu select **IBP ZERO**.
5. From the **IBP ZERO** menu select **IBP ZERO**.
6. After the zero calibration is successful, return to the normal screen.
7. Set the Patient simulator to an IBP value of 100 mmHg.
8. From the **MAINTENANCE** menu, select **IBP PRESSURE CAL**.
9. From the **IBP PRESSURE CAL** menu, set **CAL PRESSURE** to 100 mmHg.
10. From the **IBP PRESSURE CAL** menu, select **CALIBRATE**.
11. After the calibration is successful, return to the normal screen.
12. Set the Patient Simulator to the following IBP static values: 40 mmHg, 100 mmHg, and 200 mmHg.
13. Check that the unit displays the following values respectively: 40± 1 mmHg, 100± 2 mmHg, and 200± 4 mmHg.
14. Set the Patient Simulator to output an arterial wave with a value of 120/80.
15. Check that the unit displays the following values: Systolic 120 +/- 2%, Diastolic 80 +/- 2%.
16. Confirm that the corresponding waveform is displayed correctly.
17. Unplug the IBP sensor. **IBP SENSOR OFF** should be displayed in the Message Area in the top right corner of the display.

3.0 *Parts*

3.1 Exploded Views of the Trio Monitor

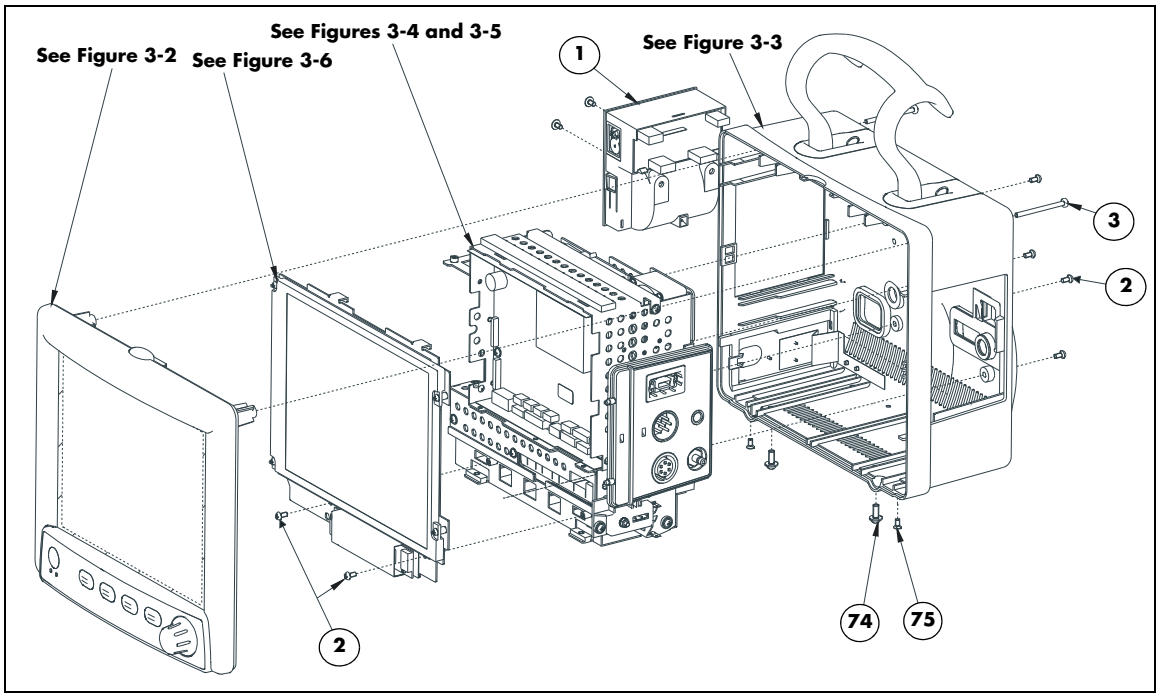


FIGURE 3-1 Main Sub-Assembly

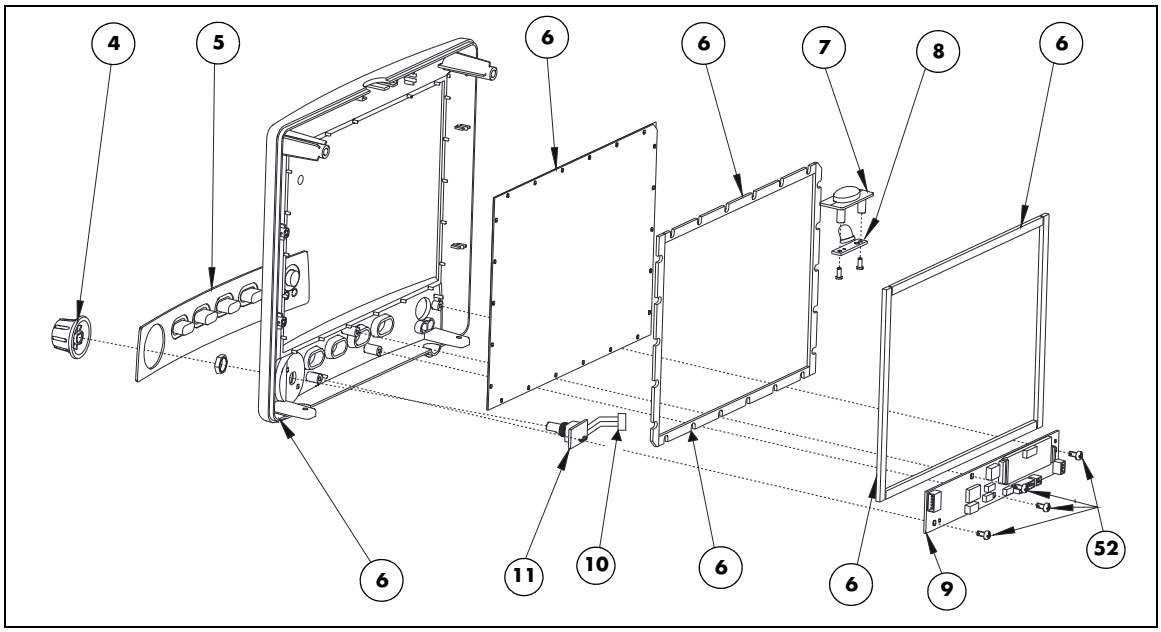


FIGURE 3-2 Front Panel Sub-Assembly

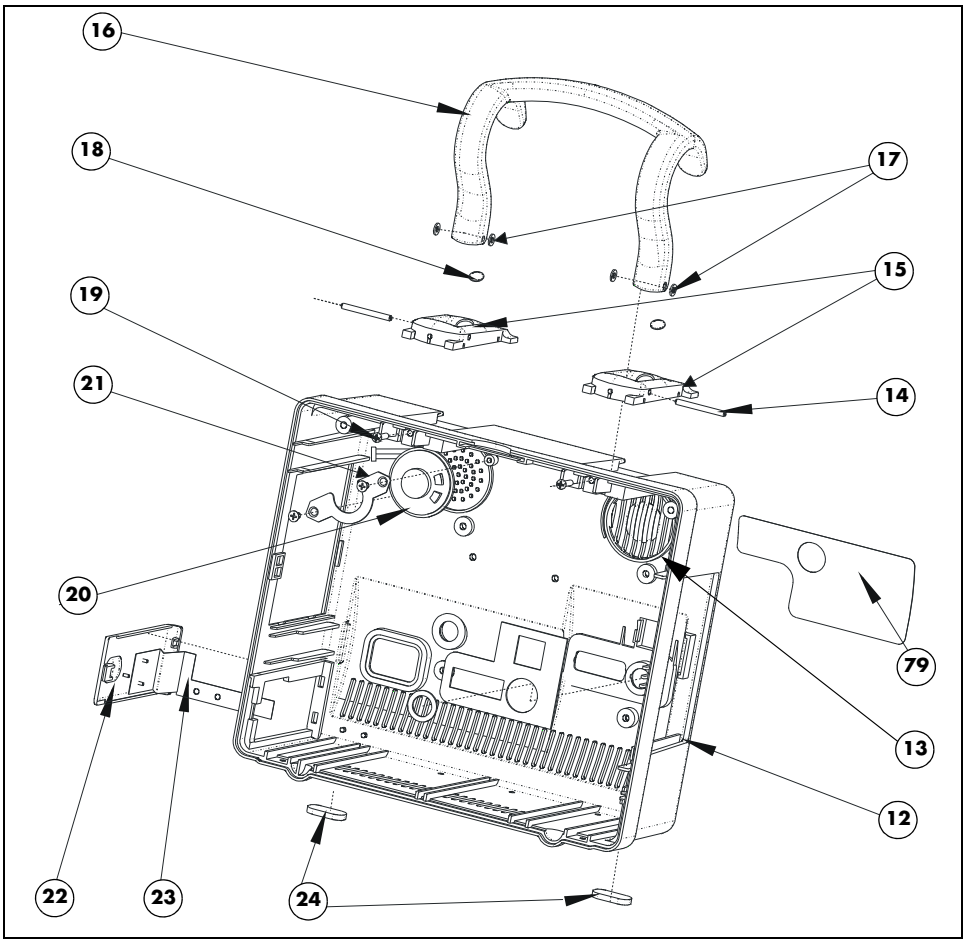


FIGURE 3-3 Rear Case Sub-Assembly

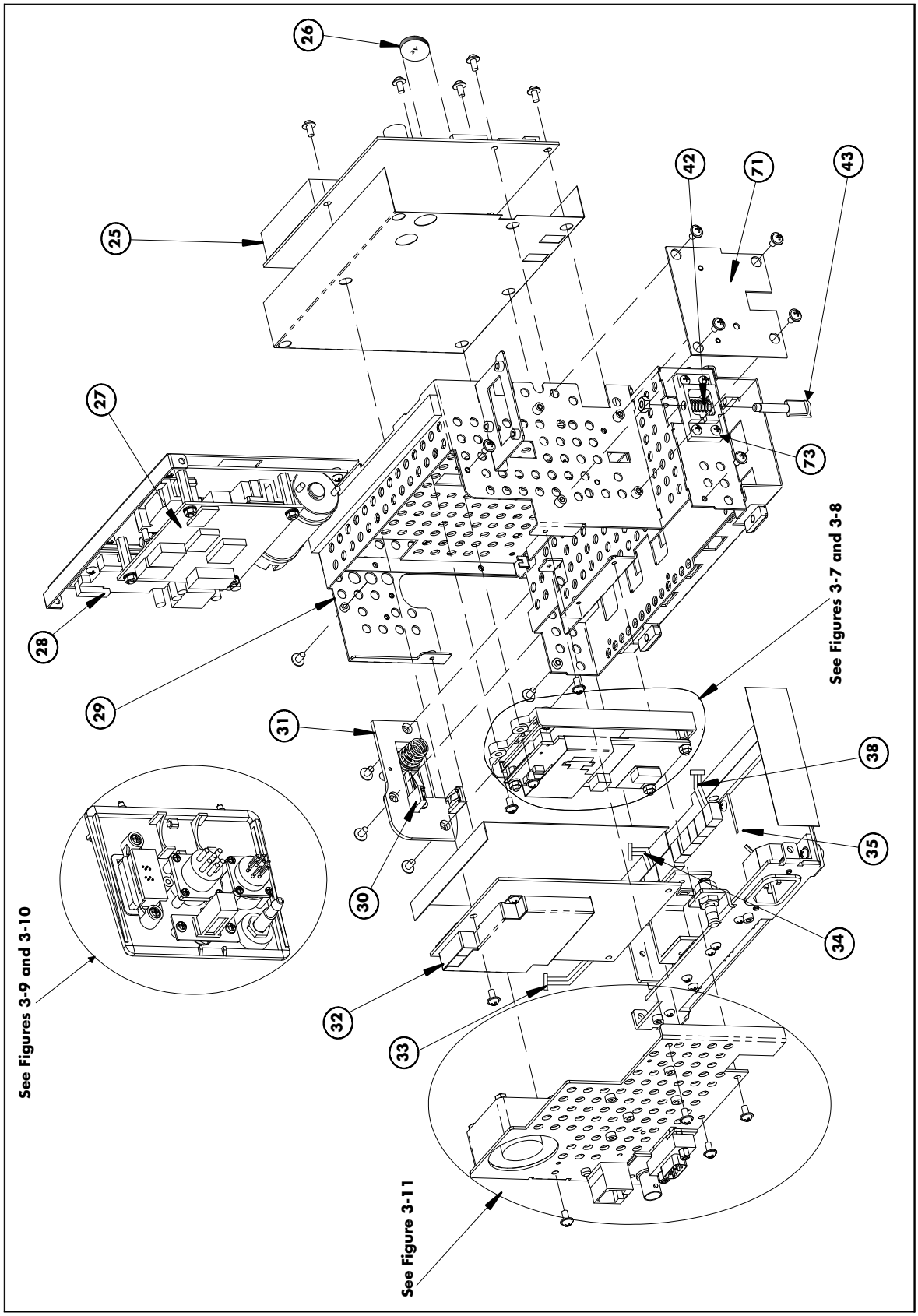


FIGURE 3-4 Main Chassis Sub-Assembly (SLA)

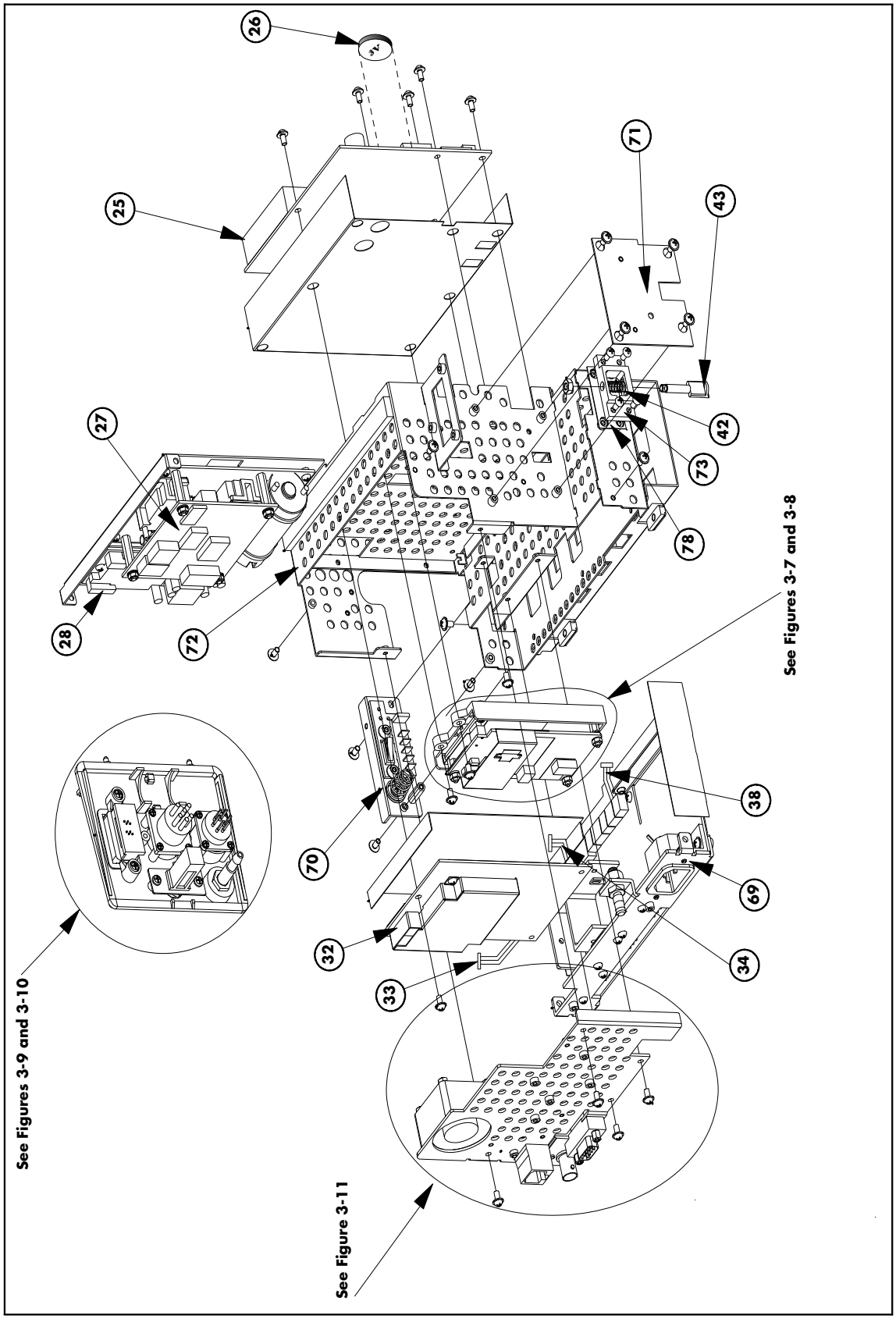


FIGURE 3-5 Main Chassis Sub-Assembly (Li Ion)

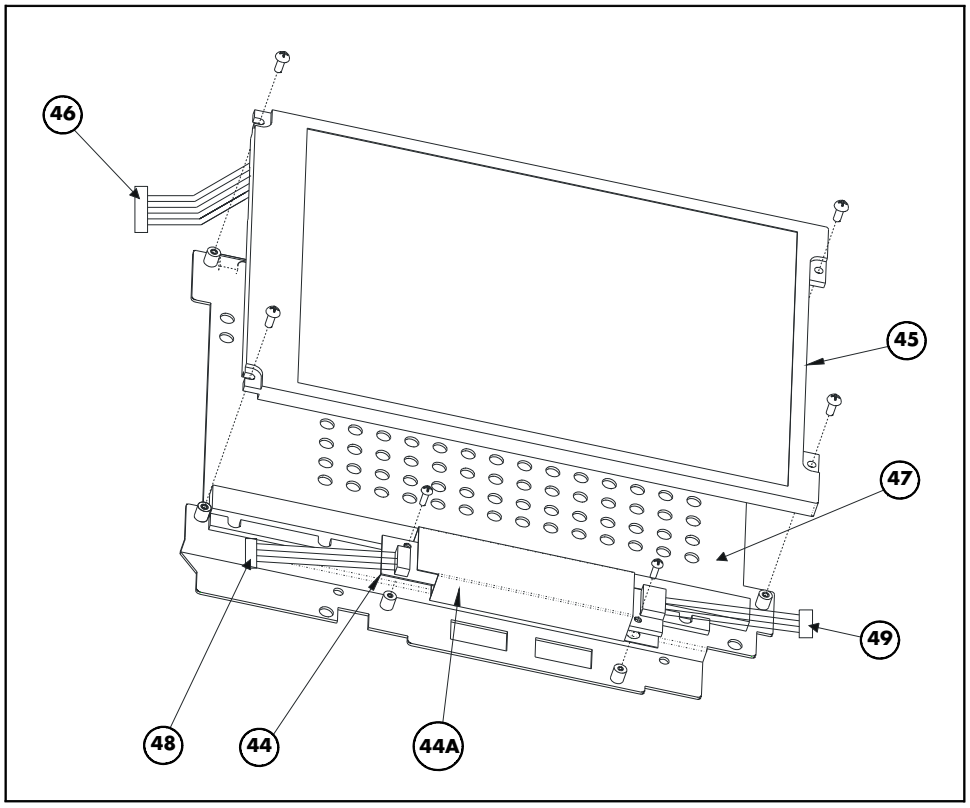


FIGURE 3-6 Display Sub-Assembly

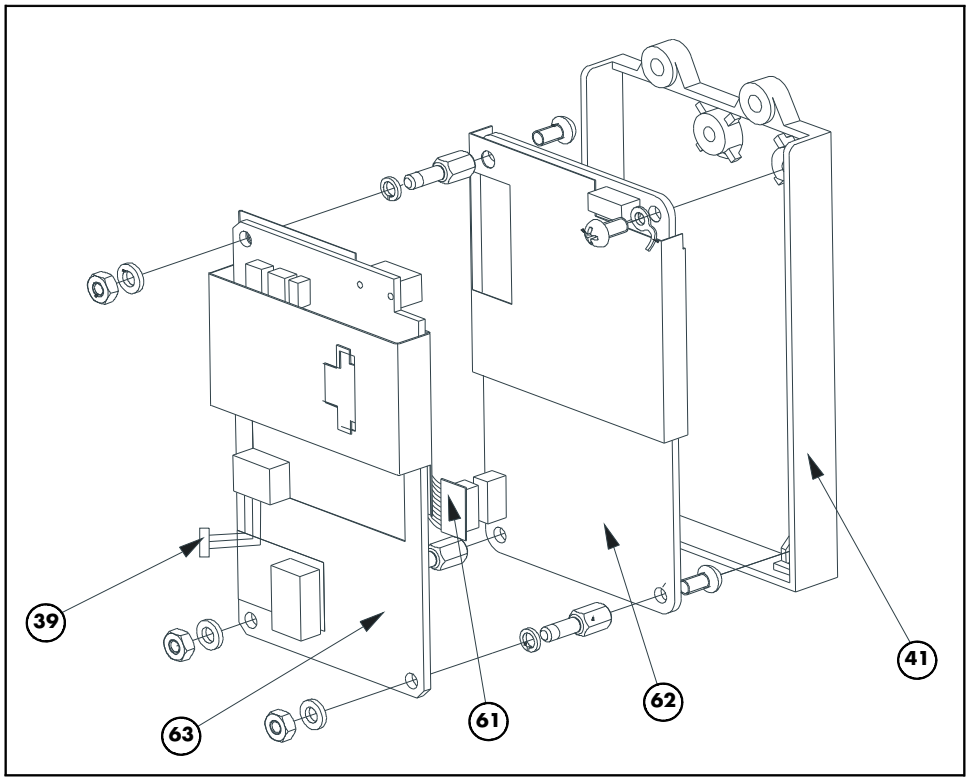


FIGURE 3-7 Masimo SPO_2 Sub-Assembly

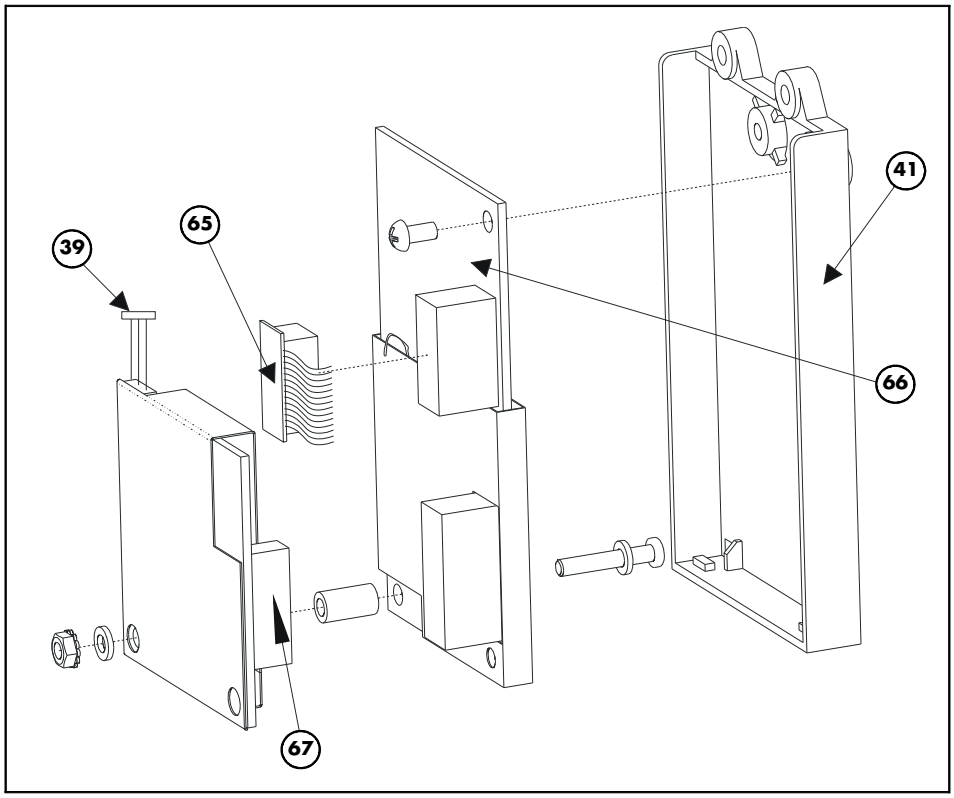


FIGURE 3-8 Nellcor SPO_2 Sub-Assembly

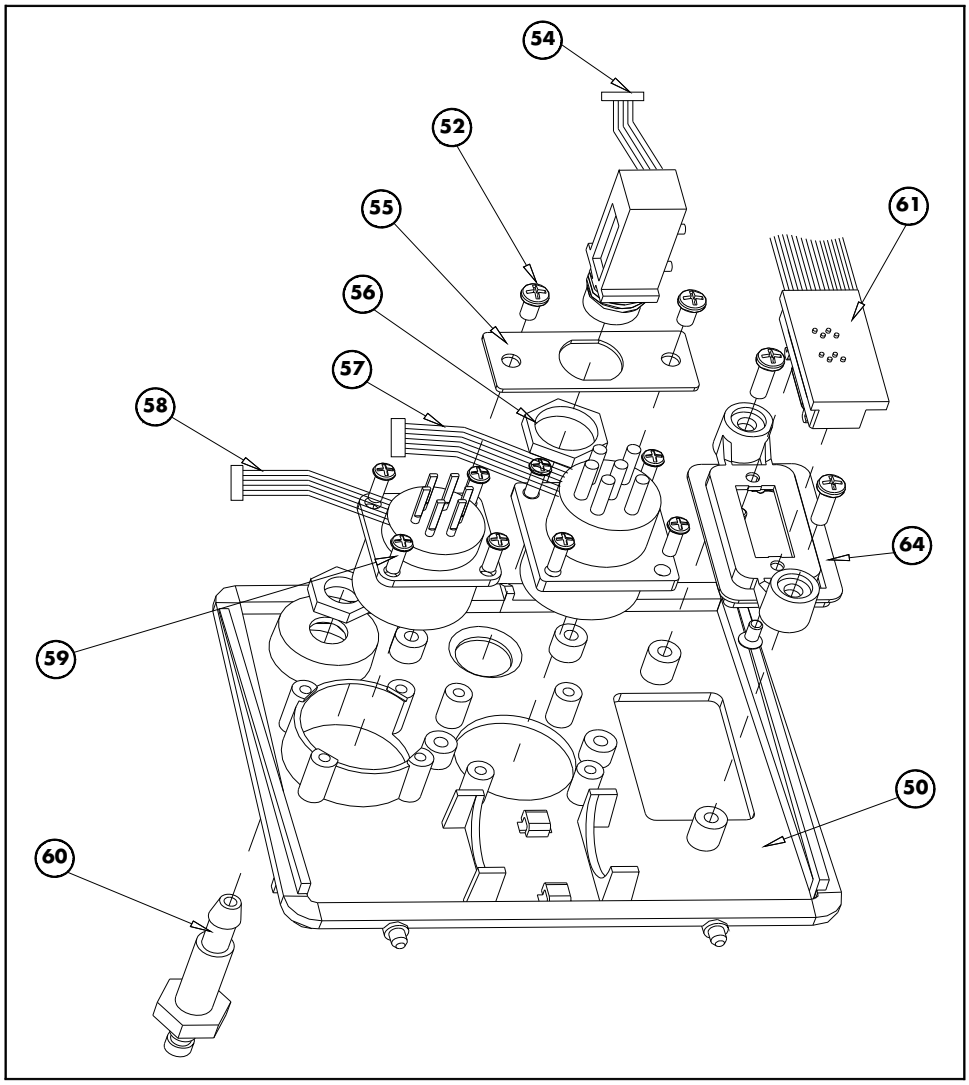


FIGURE 3-9 Right Side Panel Sub-Assembly (Masimo)

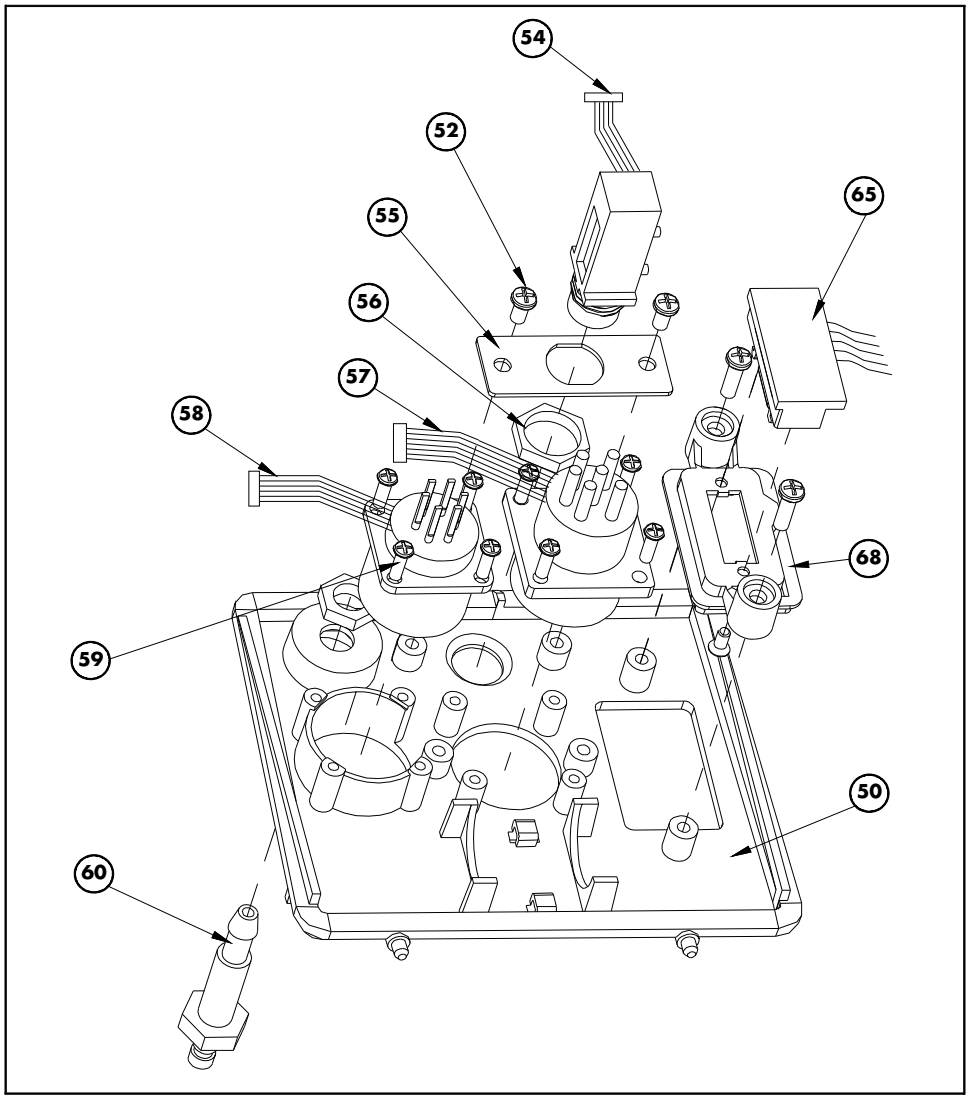


FIGURE 3-10 Right Side Panel Sub-Assembly (Nellcor)

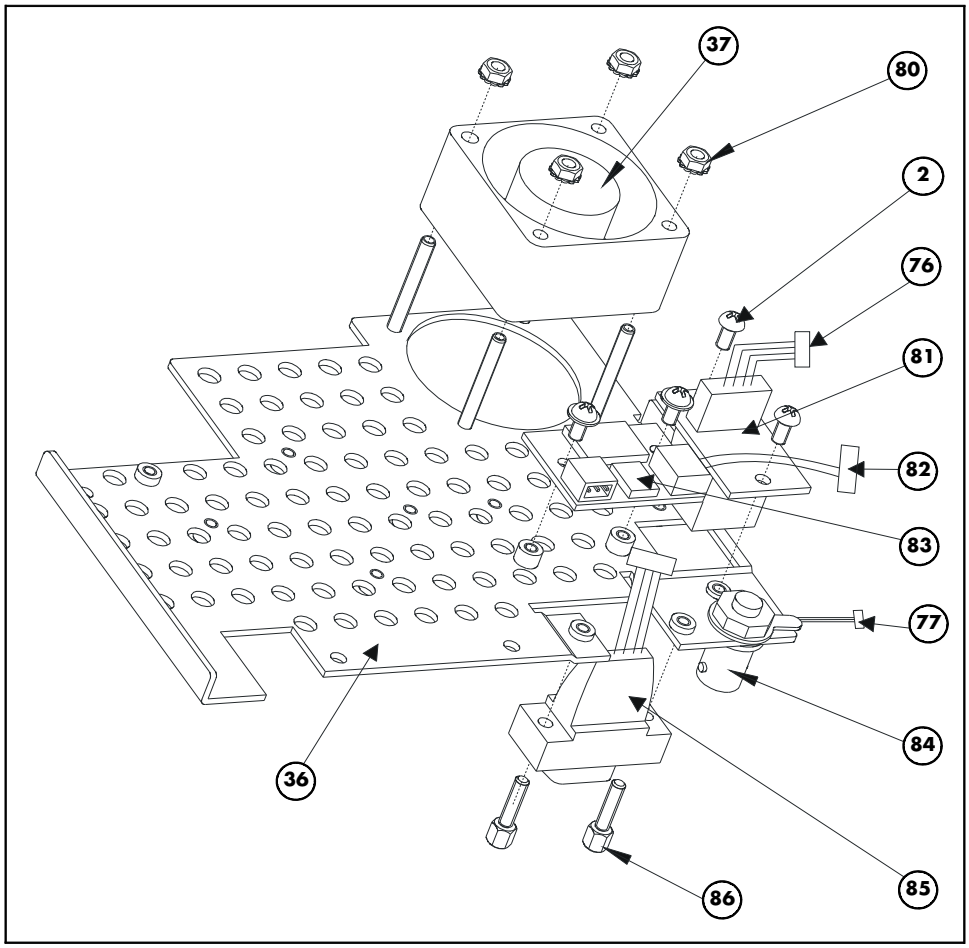


FIGURE 3-11 Rear Panel Sub-Assembly

3.2 Parts Listing

REF. NUMBER	PART NUMBER	DESCRIPTION
1	0161-00-0023	Recorder
NS	0380-00-0456	Recorder door
NS	0380-00-0454	Recorder filler panel
NS	0334-00-2665	Label, Paper Reload
2	0211-00-0143	Cross panhead screw M3 x 6
3	0211-00-0142	Screw M3 x 40
4	0366-00-0110	Knob
5	0330-00-0041-01	Keypad overlay w/freeze key
5	0330-00-0041-21	Keypad overlay w/normal screen
6	0380-00-0455	Front bezel w/glare screen
7	0380-00-0441	Alarm light lens
8	0671-00-0240	Alarm light panel PCB
9	0671-00-0237 0671-00-0064	Keypad PCB (Freeze Key) Keypad PCB (Normal Screen Key) for Serial Number MC05000-XX or Greater
10	0012-00-1488	Encoder Cable
11	0311-00-0133	Encoder PCB
12	0380-00-0439 0380-00-0524	Back Housing, Trio w/RCD for Serial Number lower than MC05000-XX Back Housing, Trio w/Serial Port, Serial Number MC05000-XX or Greater
13	0354-00-0114	Fan washer
14	0226-00-0029	Dowel
15	0367-00-0082	Handle shoe (mount)
16	0367-00-0081	Handle
17	0221-00-1027	Friction washer
18	0348-00-0203	Rubber bumper
19	0213-00-4013	Cross panhead tipless tapping screw PT4 x 14
20	0012-00-1487	Speaker cable assembly
21	0386-00-0292	Speaker Bracket
22	0380-00-0440	Battery door
23	0346-00-0050	Battery door tether
24	0348-00-0202	Foot
25	0671-00-0056	CPU Board with 4 MB RAM
26	0146-00-0078	3V lithium battery
27	0104-00-0037	NIBP assembly
28	0671-00-0241	IBP PCB
29	0441-00-0178	Main chassis
30	0012-00-1494	Cable, charge assembly, lead acid

REF. NUMBER	PART NUMBER	DESCRIPTION
31	0386-00-0293	Bracket, charge assembly, lead acid
32	0671-00-0239	ECG/RESP/TEMP PCB
33	0012-00-1491	ECG/RESP/TEMP Cable
34	0012-00-1477	Power Supply cable (J5/P12)
35	0671-00-0235	Power Supply board (SLA)
36	0386-00-0333	Rear Chassis Plate
37	0119-00-0197	Fan only
38	0012-00-1478	Power Supply cable (J4/P11)
39	0012-00-1492	SpO_2 Cable, to CPU board
41	0406-00-0831	SpO_2 Bracket
42	0214-00-0249	Spring, batter lever
43	0367-00-0083	Battery lever
44	0671-00-0250	HV Inverter PCB
44A	0349-00-0342	Mylar Shield
45	0160-00-0075	8.4"TFT Display screen
46	0012-00-1485	Cable, TFT screen
47	0406-00-0823	Display screen bracket
48	0012-00-1486	Cable, HV Inverter PCB to PS
49	0012-00-1484	Cable HV Inverter PCB to Display
50	0380-00-0443	Connector panel
52	0213-00-4014	Cross slotted panhead tapping screw M3 x 6
54	0012-00-1468	TEMP cable
55	0386-00-0295	TEMP connector panel
56	0219-00-0007	TEMP connector nut
57	0012-00-1466	IBP cable
58	0012-00-1465	ECG cable
59	0213-00-4015	Cross slotted panhead tapping screw M2.5 x 8
60	0103-00-0535	Connector, 'RECTUS'
61	0012-00-1662	Masimo flex cable
62	0671-00-0243	MS-7 SpO_2 bd., Masimo (below S/N 21963-I8)
	0671-00-0271	MS-7 SpO_2 bd., Masimo (S/N 21963-I8 and above)
63	0671-00-0246	MS-7 isolated power bd., Masimo
64	0380-00-0442	Cable shroud, Masimo
65	0012-00-1661	Nellcor SpO_2 connector., Trio
66	0671-00-0066	Nell-3 SpO_2 bd., Nellcor
67	0671-00-0247	Isolated power bd., Nellcor
68	0380-00-0444	Cable shroud, Nellcor

REF. NUMBER	PART NUMBER	DESCRIPTION
69	0671-00-0051	Power Supply PCB, Lithium Ion battery option
70	0386-00-0303	Charge Assembly, Lithium Ion battery option
71	0436-00-0217	Recorder mounting plate
72	0441-00-0180	Main chassis, Lithium Ion battery option
73	0380-00-0483	Base, battery latch
74	0211-00-1038	Screw, M4x10, Phillips, Pan Head
75	0211-24-0306	Screw, M3x6 Phillips, Flat Head
76	0012-00-1496	Cable, CPU board to Ethernet
77	0012-00-1497	Cable, CPU board to Analog Out
78	0221-00-0142	Adjustment washer, Lithium Ion battery option
79	0334-00-2634-03	Label, Rear info
80	0220-00-0098	Nut w/captive lock washer, M3
81	0671-00-0069	Ethernet port board
82	0012-00-1659	Cable Assembly, converter board to CPU board
83	0671-00-0068	Converter board, Serial Port
84	0136-00-0470	BNC socket, Analog Out
85	0012-00-1658	Cable assembly, Serial Port
86	0217-00-0038	Stud screw, Serial Port
See FIGURE 4-1	0012-00-1489	Cable, alarm to keyboard
See FIGURE 4-1	0012-00-1490	Cable, Recorder to PS board
See FIGURE 4-1	0012-00-1493	Cable, Recorder to CPU board
See FIGURE 4-1	0012-00-1495	Cable, CPU board to VGA
See FIGURE 4-1	0012-00-1499	Cable, CPU board to NIBP Module
See FIGURE 4-1	0012-00-1500	Cable, CPU board to Keyboard
N/S	0334-00-2627-001	Parameter Connector panel overlay w/Masimo IBP
N/S	0334-00-2627-004	Parameter Connector panel overlay w/Masimo SPO_2
N/S	0334-00-2627-009	Parameter Connector panel overlay w/Nellcor IBP
N/S	0334-00-2627-012	Parameter Connector panel overlay w/Nellcor SPO_2

4.0 *Repair Information*

4.1 Introduction

This chapter of the Service Manual provides the necessary technical information to perform repairs to the instrument. The most important prerequisites for effective troubleshooting are a thorough understanding of the instrument functions as well as an understanding of the theory of operation.

This page intentionally left blank.

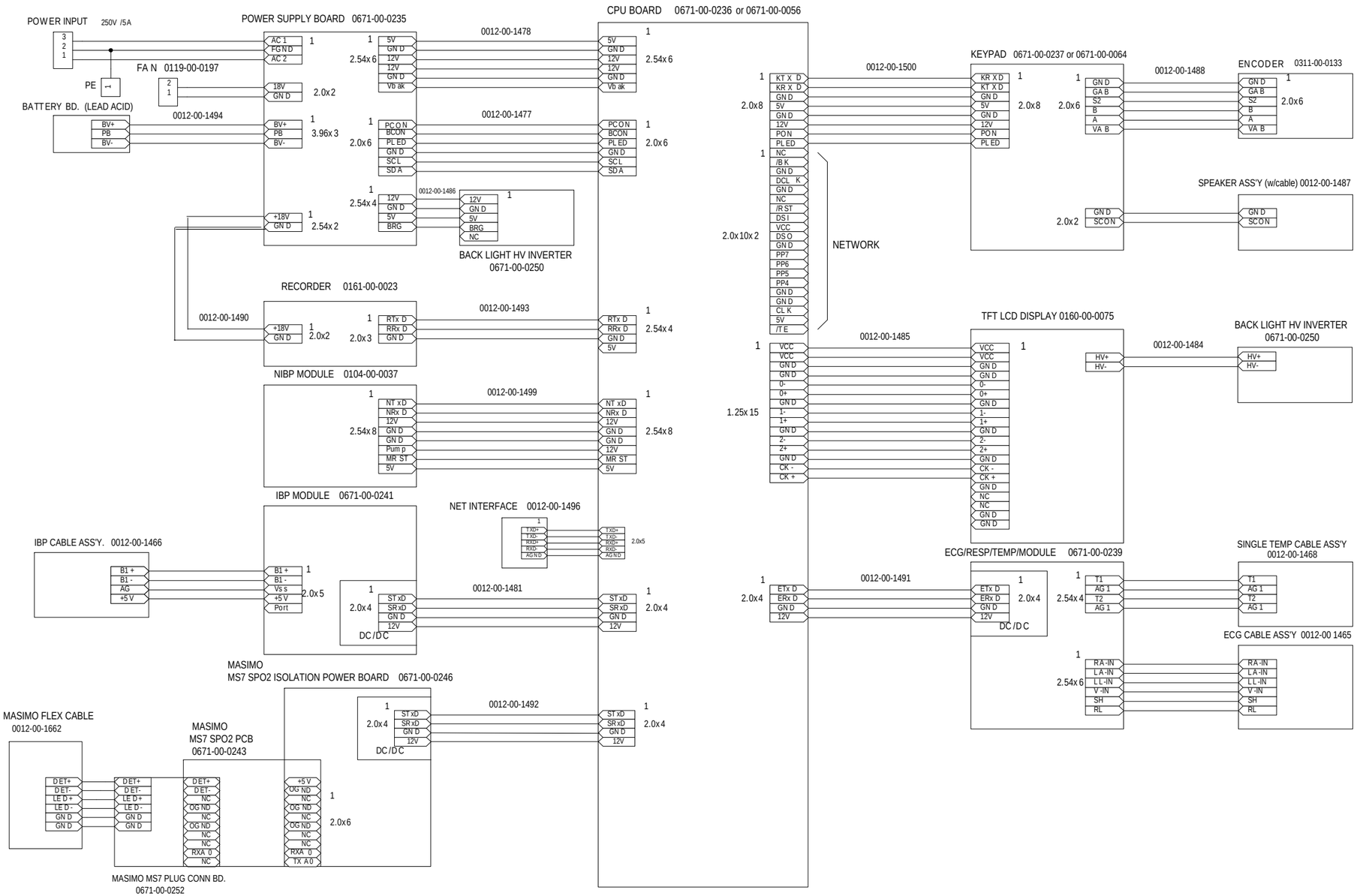


FIGURE 4-1 Trio Signal Connection Diagram (Masimo SET®)

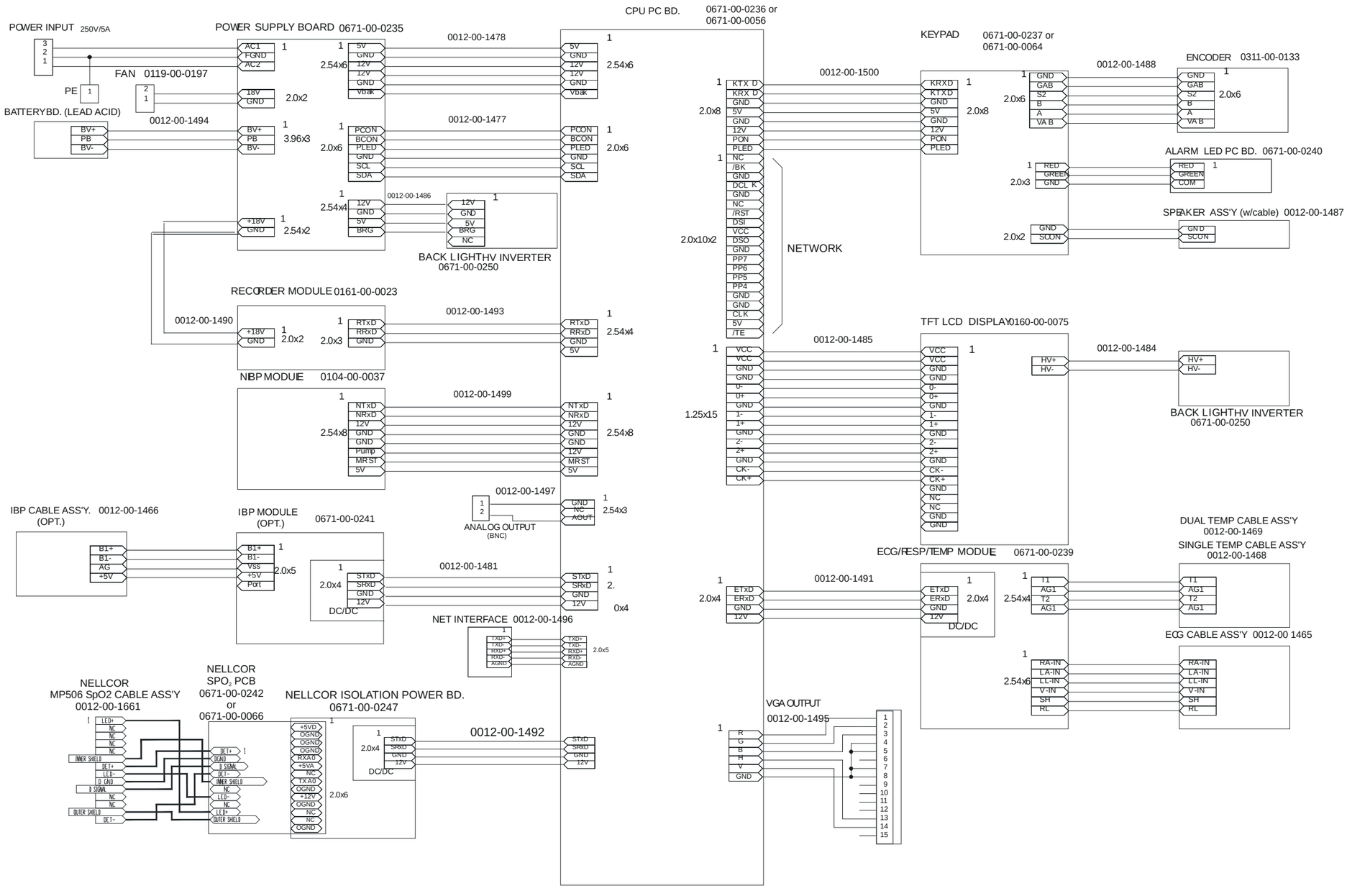


FIGURE 4-2 Trio Signal Connection Diagram (Nellcor)

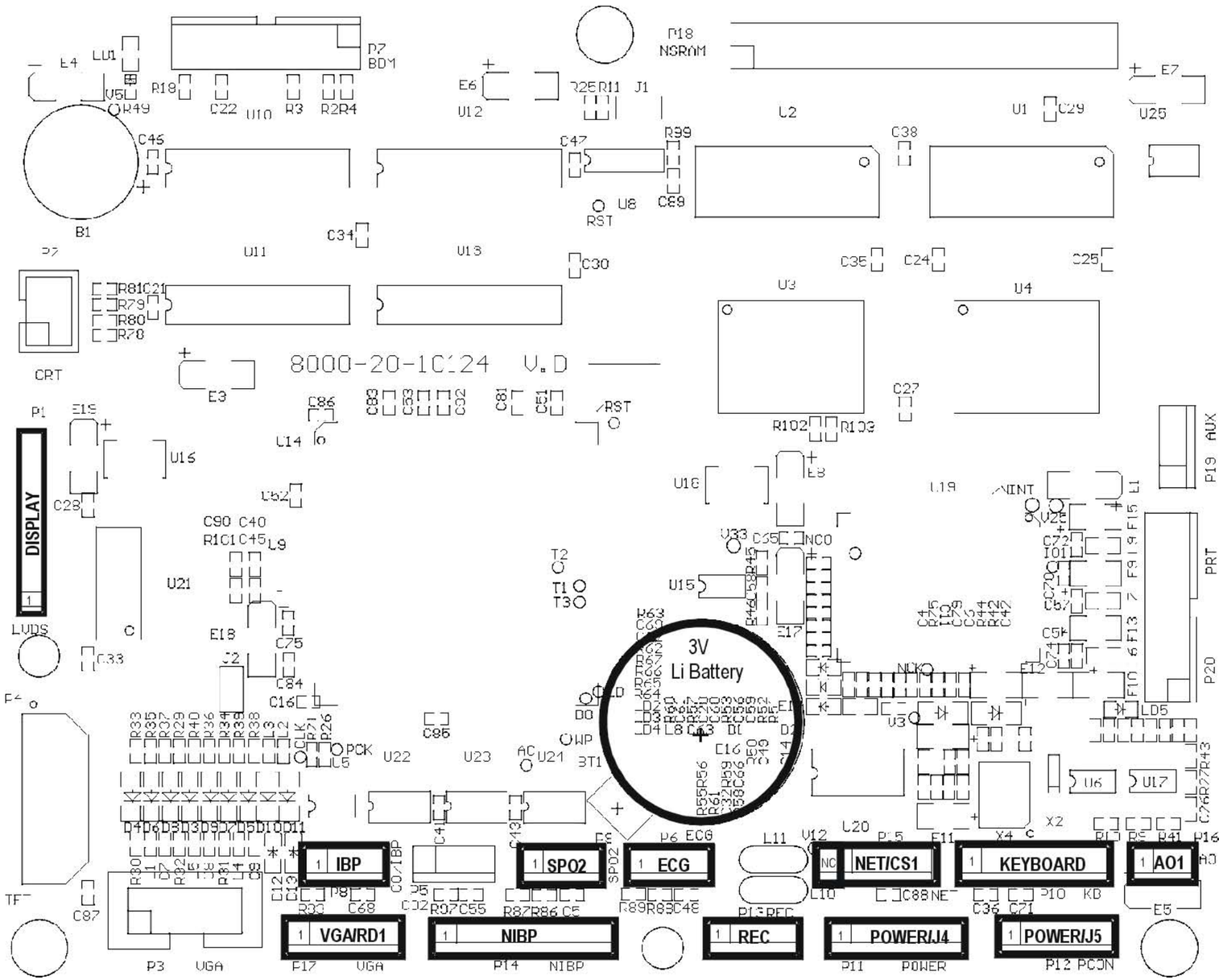


FIGURE 4-3 CPU PCB Connector Reference

FRONT OF TRIO MONITOR

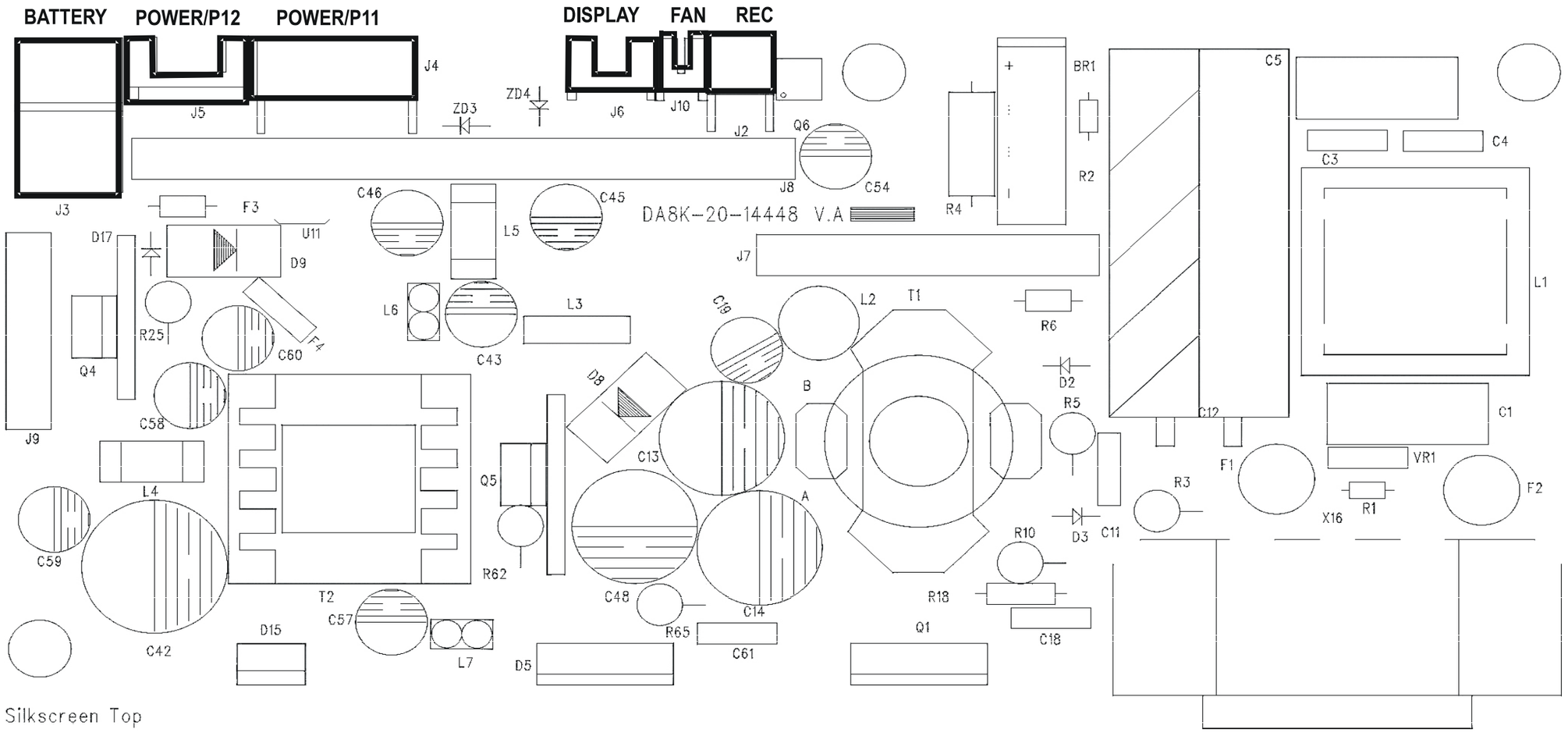


FIGURE 4-4 Power Supply PCB (Lead Acid Battery) Connector Reference

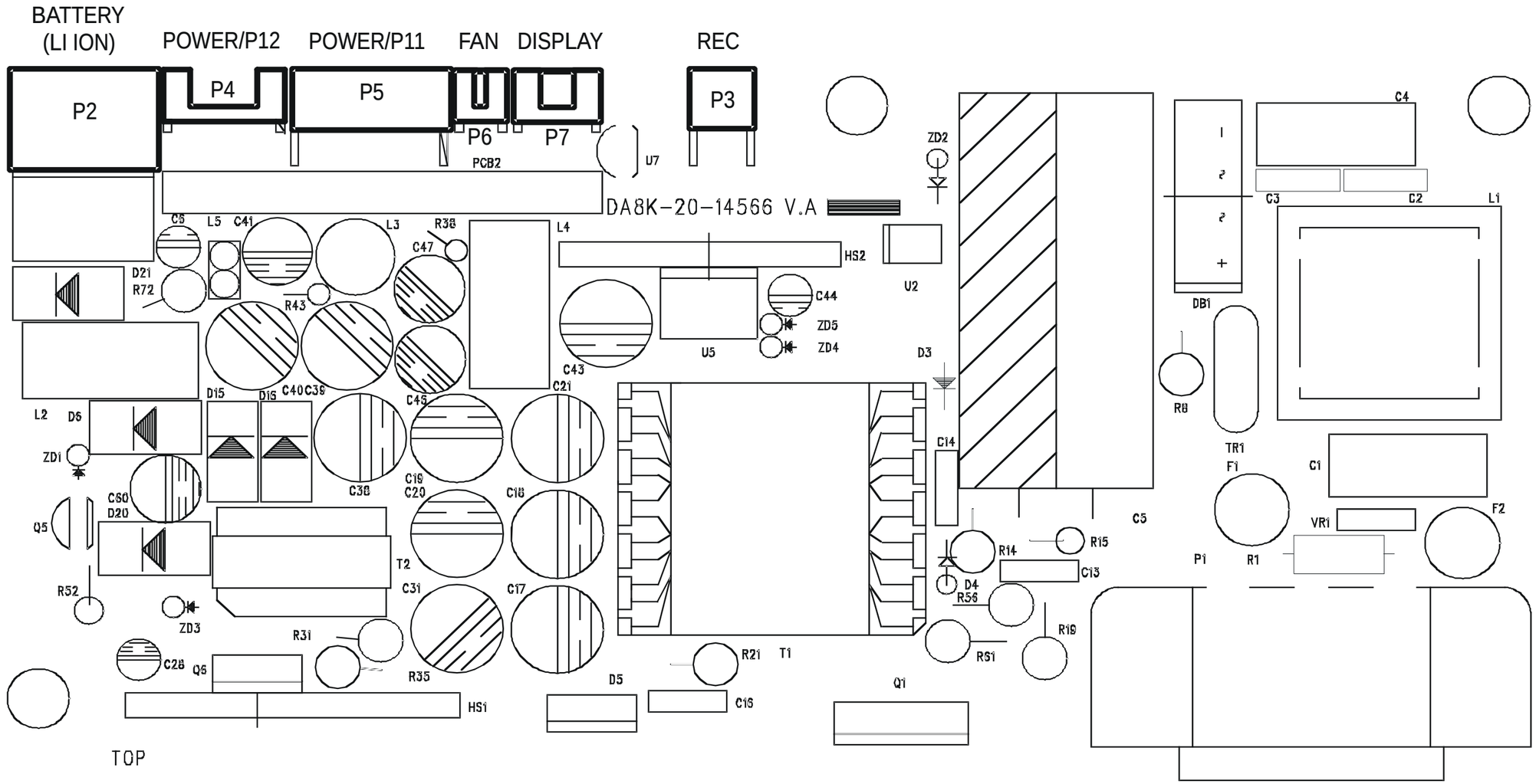


FIGURE 4-5 Power Supply Pcb (Lithium Ion Battery) Connector Reference

This page intentionally left blank.

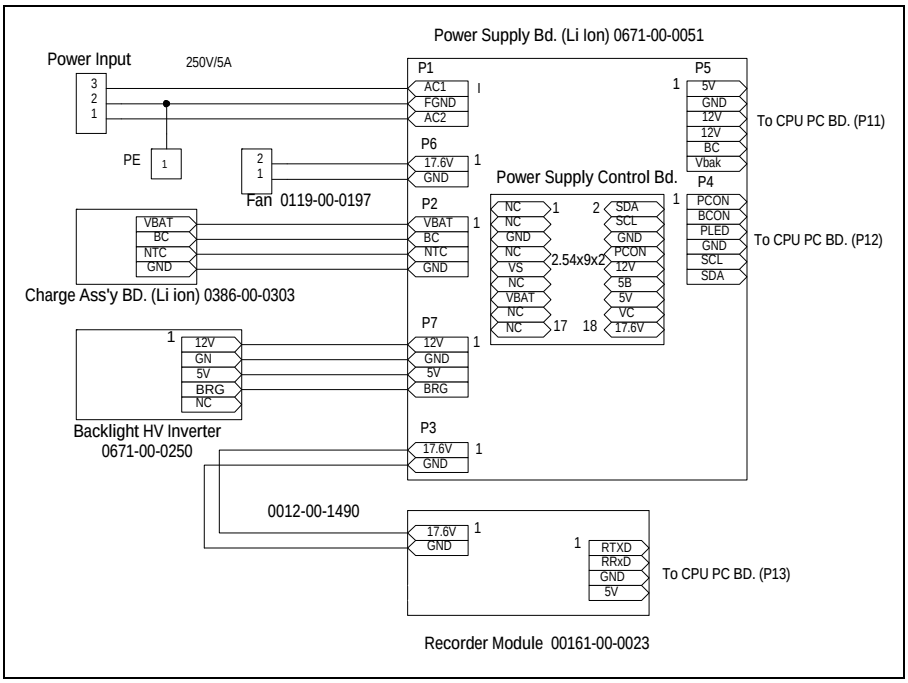


FIGURE 4-6 Power supply board (LI Ion battery) signal connection diagram

Serial Port Converter Board P/N 0671-00-0068

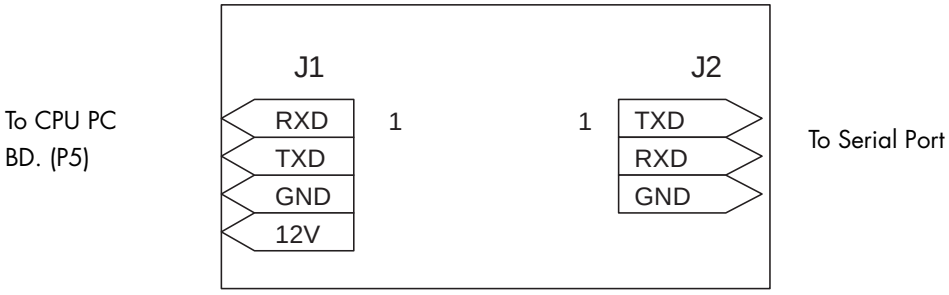


FIGURE 4-7 Serial Port Converter board signal connection diagram

4.2 Single Temp Cable Assembly

P/N 0012-00-1468

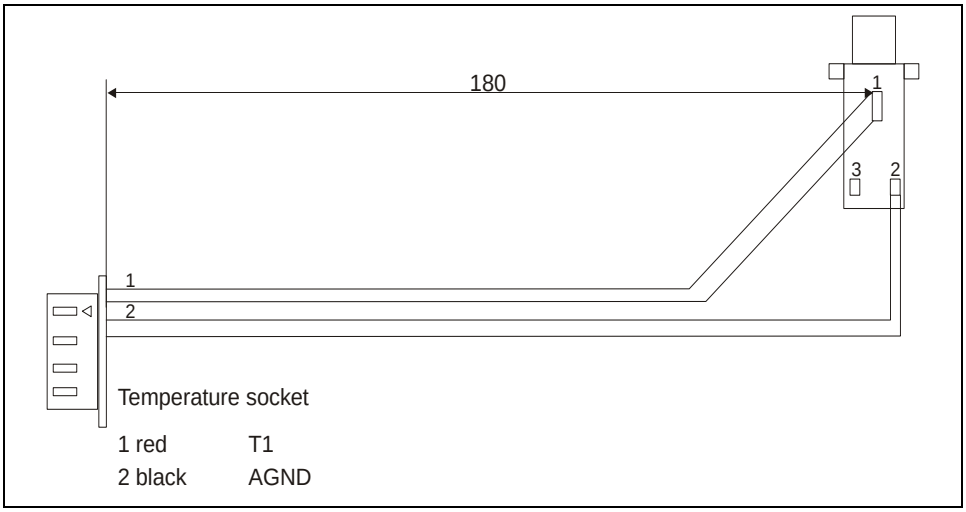


FIGURE 4-8 Single Temp Cable Assembly

4.3 ECG Cable Assembly

P/N 0012-00-1465

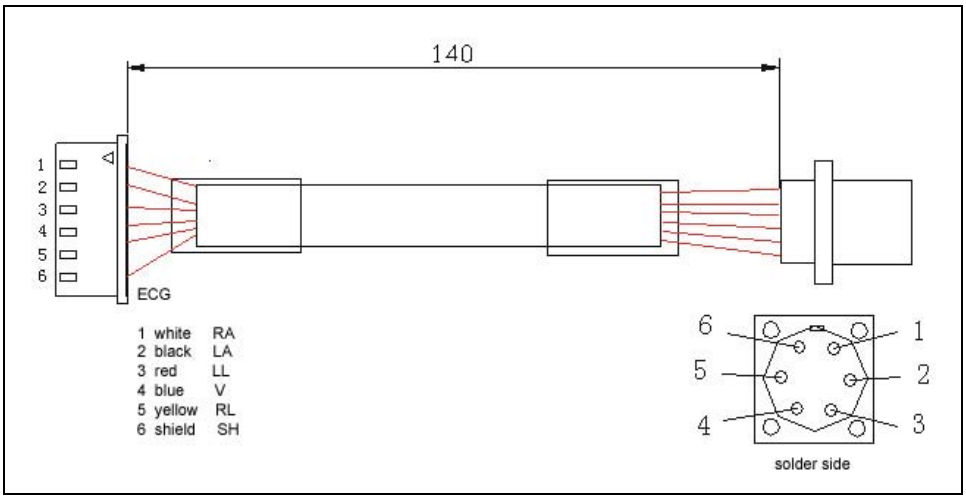


FIGURE 4-9 ECG Cable Assembly

4.4 Troubleshooting

During transportation, storage and use of the **Trio** Monitor, various factors may result in **Trio** Monitor failures or affect normal operation of the device. Some of these factors include: Unstable network voltage, changing environmental temperature, physical damage or component aging. During failure conditions, qualified service technicians should perform module-level service according to the failure classification listed in the table below. Module-level service is defined as analysis, replacement or test of any module or modules that may be determined defective within the device. These modules include: Power board, main control board, TFT assembly, cable or parameter module. The repair operation must be conducted under specific environmental conditions by a qualified service technician with access to special test equipment.

4.4.1 Module-level Troubleshooting

Device Failures

MESSAGE/PROBLEM	REASON	SOLUTION
No display after power-on	Blown fuse	Replace fuse
Power indicator does not light	Power Supply defective	Replace Power Supply
Fan does not run	Defective component or PCB	Replace component or PCB
No display after power-on or black screen during operation, however, power indicator lights on and fan runs normally	Main control board failure or display failure	Replace CPU PCB or Display to confirm failure
Characters are displayed normally, however waveforms are displayed intermittently	Data communication error between main control board and parameter module	Based on error prompt, replace CPU PCB, ribbon cable or parameter module to confirm failure
An operation or measurement function is disabled	CPU PCB or corresponding parameter PCB damage	Examine CPU PCB and corresponding parameter PCB
Device responds slowly	Poor performance of power board	Check power supply and grounding system
		Replace Power Supply board
	Poor performance of main control board	Replace CPU PCB
	Poor connection of power supply or CPU PCB	Replace or repair connectors

Display Failures

MESSAGE/PROBLEM	REASON	SOLUTION
When powering on the device, there is no display or display goes black during normal operation	HV inverter PCB damage	Connect external VGA display to confirm the Failure, replace HV inverter PCB
	Defective display cable	Repair or replace cable
	Damage of CPU PCB	Replace CPU PCB

Operation, Recording

MESSAGE/PROBLEM	REASON	SOLUTION
Keys or Navigator™ knob disabled	Keypad or Navigator knob is damaged	Replace keypad or Navigator knob
	Keypad cable is damaged	Replace or repair keypad cable
Sound is distorted or mute	Keypad failure	Replace keypad
	Speaker or cable failure	Replace speaker or cable
Recorder will not print	Recorder has no paper or roller lever is not pressed down	Install paper and press down the roller lever
	Recorder failure	Replace the recorder
	Recorder cable is damaged	Replace or repair the recorder cable
Record paper skews	Bad recorder paper installation or positioning	Adjust the installation of recorder paper

Power Board Failure

MESSAGE/PROBLEM	REASON	SOLUTION
Fuse blows upon power-on	Short-circuit in power supply or other module	Replace module or PCS
		Check after power-on
Fuse blows when all loads are disconnected	Power Supply failure	Replace Power Supply
Fuse blows after connecting a specific PCB	PCB may be defective	Replace PCB
Indicators of power and main control board illuminated, however, the fan does not run and the keypad indicator does not illuminate	+12V DC power is damaged	Replace the power supply PCB
Indicators of power and main control board do not illuminate, however, the fan runs normally and the keypad indicator illuminates	+5V DC power is damaged	Replace the power supply PCB

Parameter Failure

MESSAGE/PROBLEM	REASON	SOLUTION
No ECG waveform	Poor connection of ECG electrodes	Use new electrodes to ensure good contact
	No square waveform exists during CAL self-test	Replace ECG/RESP module
	RL electrode is disconnected	Connect RL electrode
	ECG/RESP module is damaged	Replace ECG/RESP module
ECG waveform interference or abnormal ECG waveform	Electrodes are connected incorrectly	Correctly connect electrodes
	There are disconnected or intermittent electrodes	Remove any electrodes that are not used
	AC power has no grounding plug	Use grounded power cord and outlet
	ECG filter mode is incorrect	Select appropriate filter mode
	ECG/RESP module is damaged or defective	Replace ECG/RESP module
No RESP waveform or abnormal RESP waveform	Electrodes are connected incorrectly	Use RA-LL (R and F) electrode, connect correctly
	Patient is moving constantly	Keep patient calm
	ECG/RESP module is damaged or defective	Replace ECG/RESP module
TEMP value is incorrect	Temp sensor is poorly connected	Reconnect TEMP sensor
HR value is inaccurate	ECG waveform intermittent	Check ECG connections and reconnect
NIBP cuff cannot be inflated	Airway is occluded or has leakage	Adjust or repair the airway
Blood pressure intermittently cannot be measured	Cuff becomes loose or patient is moving	Keep the patient calm. Re-wrap the cuff correctly and safely
Blood pressure measurement is inaccurate	Cuff size does not fit the patient	Use the appropriate size cuff
	NIBP module defective	Replace NIBP module
No SpO_2 waveform	SpO_2 Sensor or SpO_2 module is damaged	Replace the sensor to confirm the failure
SpO_2 waveform interference	Patient is moving	Keep the patient calm
	Ambient light is very intensive	Dim the ambient lighting
SpO_2 value is inaccurate	Dye has been injected into patient's body	Remove all dyes before performing measurement

4.5 Disassembly Instructions

Before disassembling the unit, perform the following:

- Power down the unit and remove the line cord
- Remove all cable assemblies from the right side and rear of the unit
- Remove any batteries that were installed
- Perform all work on a properly grounded station

CAUTION: To ensure continued use of the Factory Defaults when the unit is powered off and on, save the Factory Defaults as the User Default Configuration after reassembly.

4.5.1 Tools Needed

- Phillips Screwdriver
- Slotted Screwdriver
- Awl or similar tool

4.5.2 Removal of the Front Housing

1. Remove two (2) 3 x 40 mm Phillips panhead screws at top right and left of rear housing.
2. Remove two (2) 3 x 5 mm Phillips flathead screws at front right and left of bottom housing.
3. Carefully pull Front Housing Assembly forward and remove from rear housing.
4. Disconnect cable assemblies from connectors P3 (speaker cable assembly) and P4 (CPU PCB to Keypad PCB cable assembly) of Keypad PCB.

4.5.3 Removal of Display

1. With Front Housing Assembly removed, place monitor face up on a flat surface.
2. Remove four (4) 2.5 x 6 mm Phillips panhead self tapping screws at corners of the 8.4" TFT display.
3. Carefully lift display from mounting bracket.
4. Disconnect cable assembly from CN2 on the HV inverter PCB, and ribbon cable at upper left of display.

4.5.4 Removal of Thermal Printhead Recorder

1. Open recorder door and remove paper roll, if installed.
2. Remove two (2) 3 x 6 mm Phillips panhead screws from rear of recorder paper compartment.
3. Insert flat blade of screwdriver into tab slots at center right and center left of recorder paper compartment.
4. Gently move tabs in toward center of paper compartment while pushing recorder out from rear housing of unit.

4.5.5 Removal of PCB Chassis Assembly

1. Remove four (4) 3 x 6 mm Phillips panhead screws from rear housing.
2. Remove two (2) 4 x 10 mm Phillips panhead screws from bottom of rear housing.
3. Carefully pull entire PCB chassis assembly, along with right side parameter panel, forward until it is completely removed from the rear housing.
4. Disconnect cable assemblies from connectors JP1 and JP3 of thermal printhead Recorder.

4.5.6 Removal of Display Mounting Plate

1. Remove two (2) 3 x 6 mm Phillips panhead screws at left and right of HV inverter PCB.
2. Gently lift display mounting plate up from chassis assembly so that locking tabs at top of mounting plate clear their slots.
3. Pull display mounting plate forward and away from chassis assembly.
4. Disconnect cable assemblies from P1 of CPU PCB (display cable assembly) and CN2 of HV inverter PCB.

4.5.7 Replacement of 3V Lithium Cell Battery

1. With the display mounting plate removed, the CPU PCB is accessible. A 3volt Lithium cell battery is installed in the battery socket at the lower center of the CPU PCB.
2. Using a small flat blade screwdriver, push the tab (located at the 7 o'clock position on the battery holder) toward outer edge of battery socket.
3. The 3 volt lithium battery should pop out of holder. Remove and discard battery.
4. With positive (+) terminal facing up, push new 3 volt Lithium battery into battery holder until tab locks battery in place.

4.5.8 Removal of Power Supply Assembly

1. Remove two (2) 3 x 6 mm Phillips panhead screws at front left and front center of PCB chassis assembly.
2. Remove two (2) 3 x 6 mm Phillips panhead screws lower left side rear and lower right side rear of PCB chassis assembly.
3. Remove cable assemblies from J2, J10, J4, J5, and J3 of Power Supply PCB.
4. Pull power supply assembly straight back from rear of PCB chassis assembly.

4.5.9 Removal of PCB Chassis Rear Panel Plate

1. Remove four (4) 3 x 6 mm Phillips panhead screws from rear panel of PCB chassis.
2. Remove rear panel plate. This will allow access to NIBP Module and optional IBP PCB.

4.5.10 Removal of NIBP/IBP PCB Mounting Plate

1. Remove two (2) 3 x 6 mm Phillips panhead screws at upper right side center and upper left side center of PCB chassis assembly.
2. Remove one (1) 3 x 6 mm Phillips panhead screw at lower left of NIBP/IBP pcb mounting plate.
3. If IBP PCB is installed, remove cable assemblies from PD1 and P2 of IBP PCB.
4. Remove cable assembly from P1 of NIBP PCB. Remove polyurethane hose from Rectus fitting on parameter panel.
5. Lift NIBP/IBP PCB Mounting Plate up and out to remove. This will allow access to ECG/RESP/TEMP PCB and SpO_2 PCB.

4.5.11 Removal of Handle

1. Remove two (2) 4 x 14 mm Phillips panhead self tapping screw at top inside front of rear housing.
2. Push handle and handle shoes toward rear of rear housing until they are removed from housing.
3. Use an awl or similar tool to push the pins through the shoes releasing the handle.

4.6 ECG Cable ESIS and Non ESIS

P/N 0012-00-1255-XX

- 01 10′ Straight Non ESIS
- 02 20′ Straight Non ESIS
- 05 10′ Straight ESIS
- 06 20′ Straight ESIS

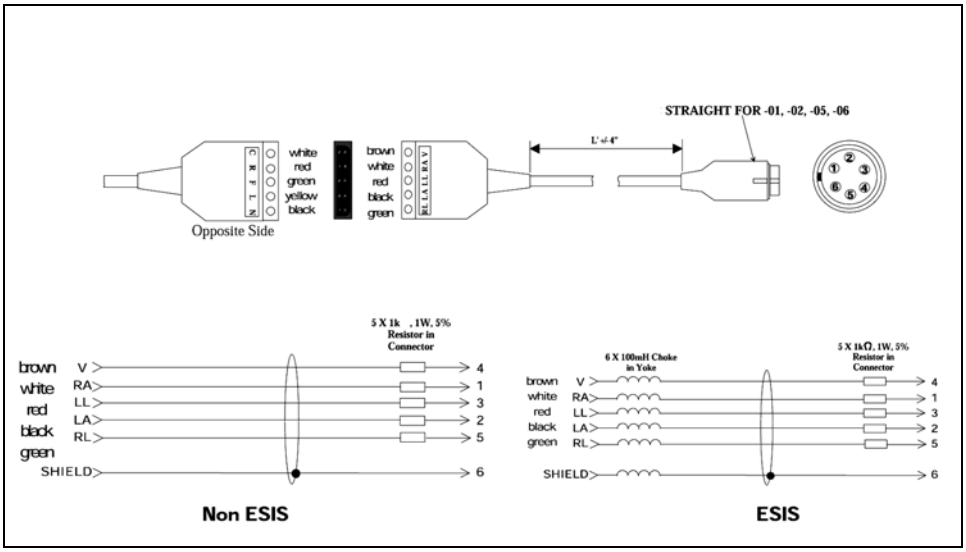


FIGURE 4-5 ECG Cable ESIS and Non ESIS (P/N 0012-00-1255-XX)

ANSI/AAMI EC53-1995		IEC CONVENTIONAL STANDARD	
LEAD	**COLOR**	**LEAD**	**COLOR**
V	Brown	Chest (C)	White
Right Arm (RA)	White	Right Arm (R)	Red
Left Leg (LL)	Red	Left Leg (F)	Green
Left Arm (LA)	Black	Left Arm (L)	Yellow
Right Leg (RL)	Green	Right Leg (N)	Black

4.7 ECG Shielded Lead Wires

P/N 0012-00-1262-XX

- 01 18" pinch 5 lead set Domestic
- 02 24" pinch 5 lead set Domestic
- 03 40" pinch 5 lead set Domestic
- 04 18" pinch 5 lead set International
- 05 24" pinch 5 lead set International
- 06 40" pinch 5 lead set International
- 13 3/40" 2/60" pinch 5 lead set Domestic
- 14 3/40" 2/60" pinch 5 lead set International
- 07 18" pinch 3 lead set Domestic
- 08 24" pinch 3 lead set Domestic
- 09 40" pinch 3 lead set Domestic
- 10 18" pinch 3 lead set International
- 11 24" pinch 3 lead set International
- 12 40" pinch 3 lead set International

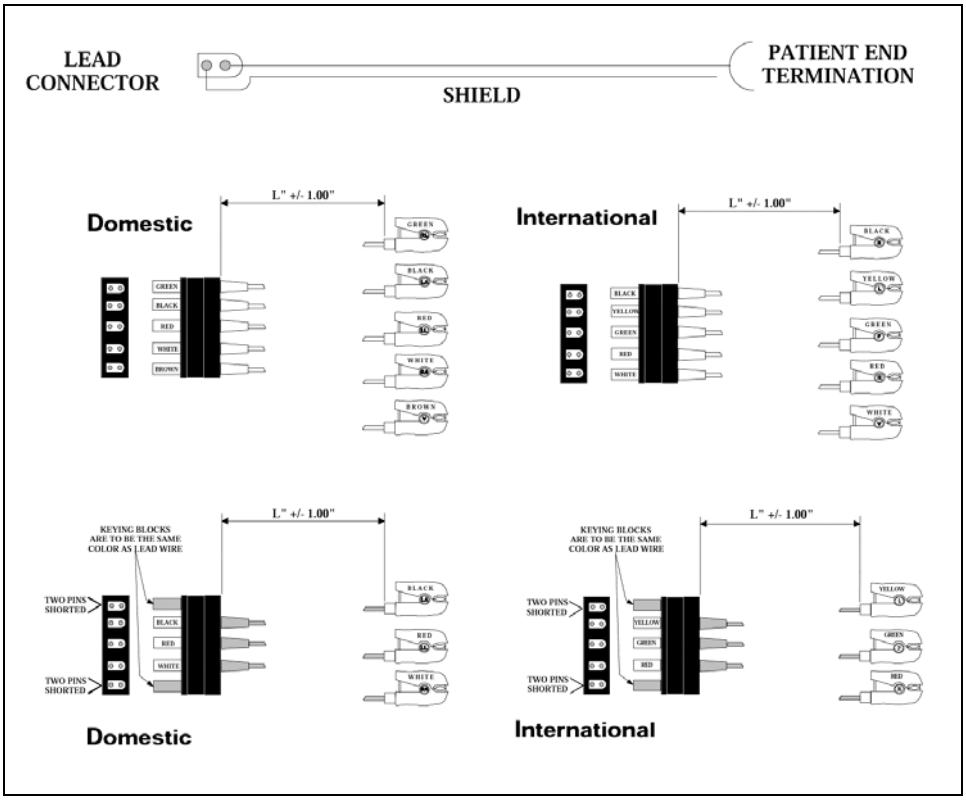


FIGURE 4-6 ECG Shielded Lead Wires (P/N 0012-00-1262-XX)

P/N 0012-00-1261-XX

- 01 18" snap 5 lead set Domestic
- 02 24" snap 5 lead set Domestic
- 03 40" snap 5 lead set Domestic
- 04 18" snap 5 lead set International
- 05 24" snap 5 lead set International
- 06 40" snap 5 lead set International
- 13 3/40" 2/60" snap 5 lead set Domestic
- 14 3/40" 2/60" snap 5 lead set International
- 07 18" snap 3 lead set Domestic
- 08 24" snap 3 lead set Domestic
- 09 40" snap 3 lead set Domestic
- 10 18" snap 3 lead set International
- 11 24" snap 3 lead set International
- 12 40" snap 3 lead set International

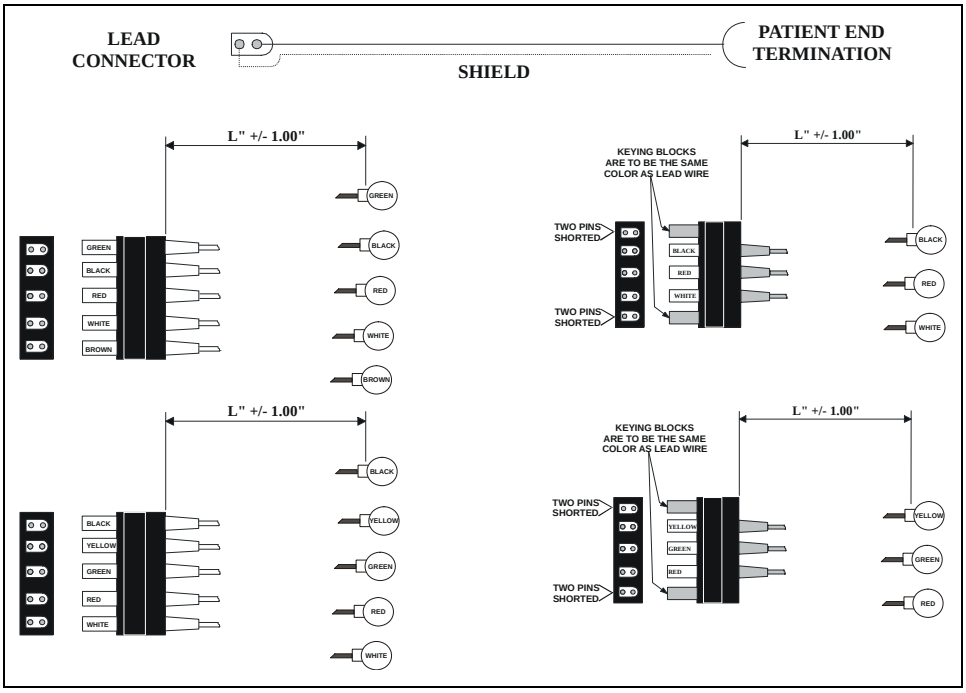


FIGURE 4-7 ECG Shielded Lead Wires (P/N 0012-00-1261-XX)

4.8 Trio Wall Mounts and Rolling Stand

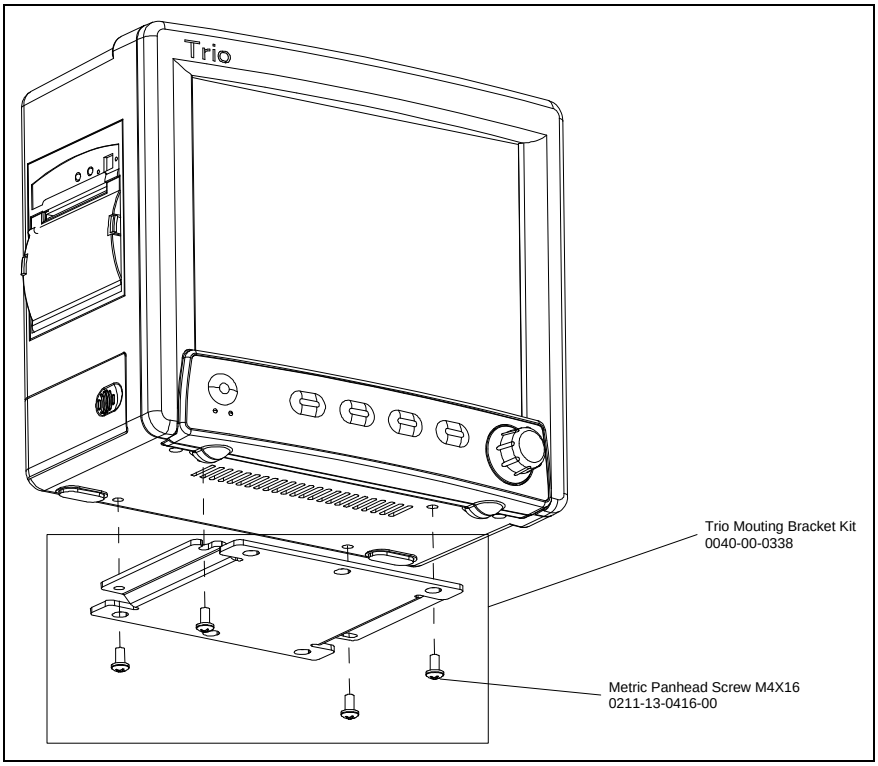


FIGURE 4-8 Mounting bracket kits

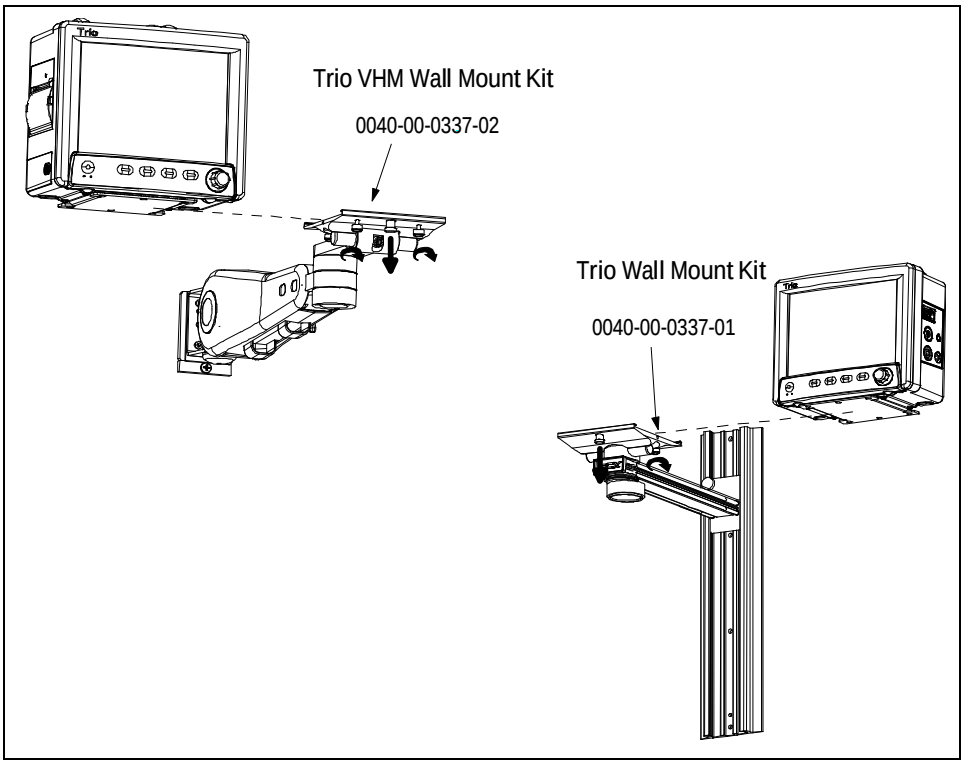


FIGURE 4-9 Mounting bracket kits

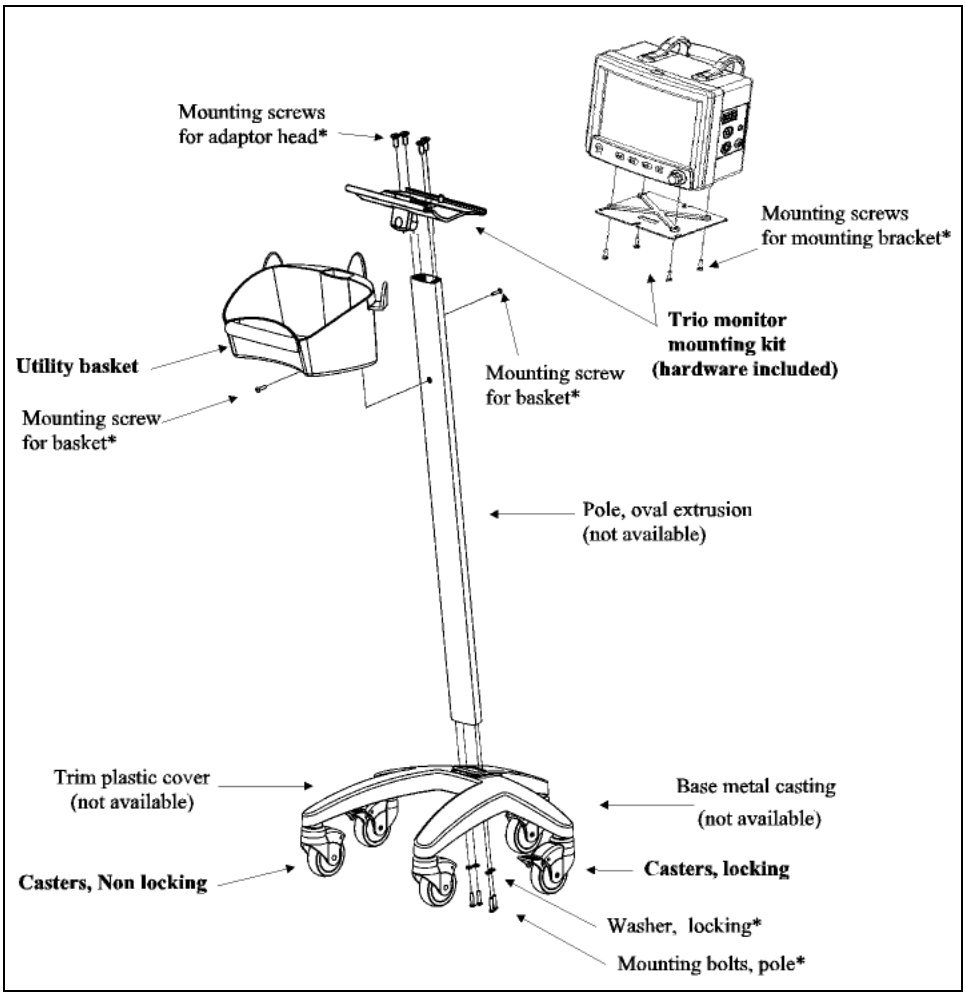


FIGURE 4-10 Trio roll stand

Replacement Parts, Trio Rolling Stand

DESCRIPTION	PART NUMBER
Trio rolling stand, value	TRIOROLLSTD
Trio monitor mounting kit	0406-00-0856-01
Casters, Non locking	0401-00-0045
Casters, Locking	0401-00-0046
Utility basket	0202-00-0166

* *Included in Trio Monitor Mounting Kit.*

5.0 *Appendix*

5.1 System Alarm Prompts

PROBLEM/MESSAGE	REASON	SOLUTION
BATTERY VOLTAGE TOO LOW	When battery voltage is too low, the monitor will automatically shut down within 5 minutes	Use AC power supply
ECG WEAK SIGNAL	The patient's ECG signal is too weak	Check if the electrodes and lead wires are connected correctly. Check the current condition of the patient.
NO PULSE	The patient's pulse signal is too weak or non-existent	Check the connection of the sensor. Check the current condition of the patient.
PNP	The pacemaker is not paced	Check the connection of the pacemaker. Check the connection of electrodes and lead wires. Check the current condition of the patient.
PNC	No pacemaker signal is captured	Check the connection of the pacemaker. Check the connection of electrodes and lead wires. Check the current condition of the patient.
ECG LEAD OFF	ECG lead is not connected correctly	Check the connection of ECG lead wires
ECG V LEAD OFF	The V lead wire of ECG is not connected correctly	Check the connection of V lead wire
ECG LL LEAD OFF	The LL lead wire of ECG is not connected correctly	Check the connection of LL lead wire
ECG LA LEAD OFF	The LA lead wire of ECG is not connected correctly	Check the connection of LA lead wire

* *XX represents all the parameter modules in the system such as ECG, NIBP, SpO_2, IBP module, etc.*

PROBLEM/MESSAGE	REASON	SOLUTION
ECG RA LEAD OFF	The RA lead wire of ECG is not connected correctly	Check the connection of RA lead wire
ECG C LEAD OFF	The C lead wire of ECG is not connected correctly	Check the connection of C lead wire
ECG F LEAD OFF	The F lead wire of ECG is not connected correctly	Check the connection of F lead wire
ECG L LEAD OFF	The L lead wire of ECG is not connected correctly	Check the connection of L lead wire
ECG R LEAD OFF	The R lead wire of ECG is not connected correctly	Check the connection of R lead wire
SpO_2 SENSOR OFF	SpO_2 sensor is not connected correctly	Check the connection of SpO_2 sensor
SpO_2: INTERFERENCE	Noise detected on the pulse signal prevents pulse discrimination	Decrease patient motion. Check sensor.
SpO_2: PULSE SEARCH	Hardware settings are being adjusted in order to discriminate a pulse waveform	Wait several seconds for saturation value to appear. If it does not appear, do one of the following: • Change to site where pulse is stronger if patient is vasoconstricted • Change or readjust sensor if loose
SpO_2: LOW PERFUSION	Patient perfusion is low	Check patient connection and patient status
SpO_2: TOO MUCH LIGHT	There is too much ambient room light for the sensor to function properly	Minimize the room light around the patient. Check sensor.
SpO_2: UNRECOGNIZED SENSOR	The sensor is not recognized by the monitor	Replace the sensor with a recommended sensor from Customer Service.
SpO_2: COMMUNICATION ERROR	The monitor and the SpO_2 modules are not communicating properly	Power the unit OFF/ON. If problem persists, notify hospital technician or Customer Service.
SpO_2: BOARD FAULT	MasimoSET® board failed to operate properly	Notify hospital technician or Customer Service.
SpO_2: SENSOR FAULT	Defective Sensor	Replace sensor
TEMP SENSOR OFF	TEMP sensor is not connected correctly	Check the connection of TEMP sensor
IBP LEAD OFF	IBP cable is not connected correctly	Check the connection of IBP cable
ECG NOISE	Excessive interference appears on the ECG signals	Check the connection of ECG lead wires. Check the current condition of the patient.
*XX ALM LMT ERR	The alarm limit of XX parameter has inadvertently deviated from standard range	If message does not clear contact Customer Service.

* *XX represents all the parameter modules in the system such as ECG, NIBP, SpO_2, IBP module, etc.*

PROBLEM/MESSAGE	REASON	SOLUTION
*XX RANGE EXCEEDED	The measured value of XX parameter has exceeded the system measurement range	If message does not clear contact Customer Service.
REAL CLOCK NEEDSET	If the monitor displays 2000-1-1, this system prompt reminds the user that the current system time is inaccurate	Reset the system time. After setting the time, the user should cycle power. This will avoid any time storage errors.
REAL CLOCK NOT EXIST	The system has no cell battery or the battery has run down	Install or replace the cell battery
SYSTEM WD FAILURE SYSTEM SOFTWARE ERR SYSTEM CMOS FULL SYSTEM CMOS ERR SYSTEM EPGA FAILURE SYSTEM FAILURE2 SYSTEM FAILURE3 SYSTEM FAILURE4 SYSTEM FAILURE5 SYSTEM FAILURE6 SYSTEM FAILURE7 SYSTEM FAILURE8 SYSTEM FAILURE9 SYSTEM FAILURE10 SYSTEM FAILURE11 SYSTEM FAILURE12	The system has a fatal error or failure	Restart the system. If message does not clear contact Customer Service.
KEYBOARD NOT AVAILABLE	The keypad cannot be used	Check the keys for abnormal depression. Contact the manufacturer for repair.
KEYBOARD COMM ERR KEYBOARD ERROR KEYBOARD FAILURE KEYBOARD ERR1 KEYBOARD ERR2	The keypad has a failure	Contact the manufacturer for repair
5V TOO HIGH 5V TOO LOW POWER ERR3 POWER ERR4 12V TOO HIGH 12V TOO LOW POWER ERR7 POWER ERR8 3.3V TOO HIGH 3.3V TOO LOW	The power supply has a failure	Restart the system. If message does not clear contact Customer Service.

* *XX represents all the parameter modules in the system such as ECG, NIBP, SpO_2, IBP module, etc.*

PROBLEM/MESSAGE	REASON	SOLUTION
CELL BAT TOO HIGH	Cell battery is defective. Incorrect cell battery installed	Replace the battery. If message does not clear contact Customer Service.
CELL BAT TOO LOW	The cell battery has become depleted. The cell battery is not installed or the connection is loose.	
RECORDER SELF TEST ERR	During the recorder self test, there is a Recorder Module communication failure	Execute **Clear Record Task** function in the recorder setup menu to reset communication between the host and the recorder. If message does not clear contact Customer Service.
RECORDER VLT HIGH RECORDER VLT LOW	The recorder module has voltage failure	Contact the manufacturer for repair
RECORDER HEAD HOT	The continuous recording time may be too long	After the recorder cools down, use again. If the problem still exists, contact the manufacturer for repair.
REC HEAD IN WRONG POSITION	The recorder roller lever is not pressed down	Press down the recorder roller lever
RECORDER OUT OF PAPER	No paper is in the recorder	Install paper into the recorder
RECORDER PAPER JAM	The paper in the recorder is jammed	Re-install the recorder paper and try again
RECORDER COMM ERR	The communication of the recorder is abnormal	Execute **Clear Record Task** from the recorder setup menu to reset communication between the host and the recorder. If message does not clear contact Customer Service.
RECORDER PAPER W.P.	The recorder paper is not installed in the correction position	Install the recorder paper in the correct position
REC NOT AVAILABLE	Cannot communicate with the recorder	Execute **Clear Record Task** from the recorder setup menu, to reset communication between the host and the recorder. If message does not clear contact Customer Service.
NIBP INIT ERR NIBP SELFTEST ERR	NIBP initialization error	Restart the system. If message does not clear contact Customer Service.
NIBP ILLEGALLY RESET	During NIBP measurement, illegal reset occurs	Check the airway of NIBP to see if there are occlusions. Then measure again. If the problem persists, contact the manufacturer for repair.
NIBP COMM ERR	No NIBP communication	Restart the system. If message does not clear contact Customer Service.

* *XX represents all the parameter modules in the system such as ECG, NIBP, SpO_2, IBP module, etc.*

PROBLEM/MESSAGE	REASON	SOLUTION
LOOSE CUFF	The NIBP cuff is not connected correctly	Re-connect the NIBP cuff.
AIR LEAK	The NIBP cuff is not connected correctly or there are leaks in the airway	Check the connection of each part or replace cuff and hose. If message does not clear contact Customer Service.
OVER PRESSURE	NIBP is in an overpressure condition.	Check for occlusion in cuff and hose. Measure again. If message does not clear contact Customer Service.
SIGNAL SATURATED	Problem occurs when measuring NIBP. The system cannot perform measurement, analysis or calculation.	Check the connection of the cuff and hose. Check patient's condition. Measure again, if the failure persists, contact the manufacturer for repair.
TIME OUT	Problem occurs when measuring NIBP. The system cannot perform measurement, analysis or calculation.	Check the connection of the cuff and hose. Check patient's condition. Measure again, if the failure persists, contact the manufacturer for repair.
CUFF TYPE ERR	NIBP cuff may be wrong size	Check if the patient size is set correctly. Replace existing cuff with correct size cuff. If the failure persists, contact the manufacturer for repair.
PNEUMATIC LEAK	NIBP airway has leaks	Check the connection of cuff and hose or replace cuff and hose. If the failure persists, contact the manufacturer for repair.
MEASURE FAIL	Problem occurs when measuring NIBP. The system cannot perform measurement, analysis or calculation.	Check the connection of the cuff and hose. Check patient's condition. Measure again, if the failure persists, contact the manufacturer for repair.
NIBP SYSTEM FAILURE	Problem occurs when measuring NIBP. The system cannot perform measurement, analysis or calculation.	Check the connection of the cuff and hose. Check patient's condition. Measure again, if the failure persists, contact the manufacturer for repair.

* *XX represents all the parameter modules in the system such as ECG, NIBP, SpO_2, IBP module, etc.*

Mindray DS USA, Inc. • 800 MacArthur Boulevard • Mahwah, NJ 07430 • USA •
Dom. Customer Service: 1.800.288.2121 • Intl. Customer Service: +1.201.995.8000 •
Dom. Fax: 1.800.926.4275 • Intl. Fax: +1.201.995.8680 • www.mindray.com

Mindray Medical Netherlands B.V.• P.O. Box 26 • 3870 CA Hoevelaken • The Netherlands •
Tel: +31 33 25 44 911 • Fax: +31 33 25 37 621

Mindray (UK) Limited • 3 Percy Road • St. John's Park • Huntingdon • Cambridgeshire PE29 6SZ •
United Kingdom • Tel: 01480 416840 • Fax: 01480 436588

Mindray Medical France SARL • Europarc Créteil •123, Chemin des Bassins •
94035 Créteil Cedex • France • Tel: (0)1.45.13.91.50 • Fax: (0)1.45.13.91.51

Mindray Medical German GmbH • Zwischen den Bächen 4 • 64625 Bensheim • Germany •
Tel: +49.6251.17524-0 • Fax: +49.6251.17524-20

Mindray Medical International Ltd. • 2813 Office Tower, Convention Plaza • No 1 Harbour Road •
Wanchai • Hong Kong • Tel: +852 2793 5596 • Fax: +852 2344 8824